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Materials and Supplies for Management of Wildlife Damage to Trees



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Materials and Supplies for Management of Wildlife Damage to Trees



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Technology & Development Program
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February 1996

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Foreword

The growth and survival of seedlings planted on National Forests has improved dramatically over the past 20 years, primarily because nurseries produce better stock, and because more care is used in handling and planting seedlings.

One remaining problem is that of animal damage to planted stock. Although livestock, rodents, and other animals take their toll, deer and elk are the primary animals browsing seedlings. By nipping off buds and shoots, deer and elk can restrict seedling growth and cause seedling mortality. Fencing plantations can greatly reduce the damage, but the cost is high. Tubes are

sometimes used to protect seedlings, but they are costly and require annual maintenance to be effective. Chemical sprays and powders have been used with varying degrees of success.

Better techniques and products to protect newly planted seedlings from animal damage need to be found. This would reduce reforestation costs, improve seedling survival and growth, and help land managers meet stocking requirements on schedule. The first step in solving this problem is to determine what techniques and products are now being used to protect seedlings or are available to be used.

This catalog is the first step in working toward a solution of the problem of animal damage to newly planted tree seedlings. It documents the various methods and products now available. The Missoula Technology and Development Center contracted with Dr. Dale Nolte of the Animal and Plant Health Inspection Service Animal Damage Control's Denver Wildlife Research Center to prepare this catalog. The USDA Forest Service's Washington Office Timber Management Reforestation Program funded the work.

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Acknowledgments

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sources of materials, contacted companies, and collected product information. Most of the illustrations were drawn by Phil Lundberg from photos and descriptions provided by the authors.

Introduction

Foraging wildlife can inflict severe damage to forest resources. Any tree is susceptible to attack. However, seedlings are the most vulnerable. Reforestation after a timber harvest or forest fire is often impeded by foraging herbivores. Seedlings are clipped or gnawed by rodents and the foliage is stripped by browsing ungulates. The resultant damage can be lethal or can impair growth rates and induce deformities. Animals also girdle established trees to feed on sapwood. Complete girdling is lethal, while partial girdling slows growth rates and provides avenues for subsequent insect or disease infestations.

A variety of available methods to reduce wildlife damage to forest resources are presented. Each approach and operation are briefly described and most are accompanied by an illustration. Advantages and disadvantages are also given, along with a list of sources to purchase materials.

The **Problem Identification** section very briefly describes identifying characteristics of selected mammals commonly associated with forest damage. The **Physical Deterrent** section describes barriers and fencing options. The section on **Traps** provides information on materials for the removal of animals. The **Toxicants** section presents means to reduce or maintain low population

densities of animals. Chemicals to reduce foraging are provided in the **Repellents** section. A section on **Frightening Devices** lists available visual aids and noisemakers to scare animals away from protected sites. The **Alternative Forage** section describes an approach to alleviate damage by providing wildlife with an alternative to eating trees. A section on **Sources** lists the addresses, phone numbers, and facsimile numbers of the manufacturers and distributors of the products described. Finally, the **Bibliography** provides sources used to prepare this manuscript and more detailed information on tools and methods to protect forest resources from damage by wildlife.

Developing a Damage Reduction Program

The most appropriate approach to reduce animal damage needs to reflect the overall objectives of the producer, as well as the conditions of the specific problem. All techniques are not feasible or appropriate for all situations. The process described below provides a reasonable approach to develop a program to reduce damage.

First, assess the severity, as well as the potential for additional damage to occur if no action is taken. Concurrently, identify the correct culprit, or the target species of your anticipated program.

Second, evaluate the feasibility of all possible approaches to alleviate the problem. No action may be the appropriate action if you decide the problem is relatively minor. Check on the legal ramifications for any action. Then evaluate all legal approaches relative to the biological, environmental, economical and sociocultural aspects

of the problem. Ascertain that your selected action will not be potentially hazardous to endangered or threatened species. An effective approach also requires that you are familiar with behavioral traits and biology of the target species. Evaluate how the environmental conditions of the site may effect your approach and the consequences of your action to the environment. Consider the likelihood that your selected method will achieve an acceptable degree of success, and whether the situation warrants the anticipated expense. Public attitudes toward potential methods also need to be considered when choosing an approach.

Third, develop a strategy to implement your efforts to reduce damage. Your strategy may incorporate several methods at once, or utilize one method to stop the damage and another to limit future problems. Inquire among experts

within the field if you need additional information or are unsure of specific requirements. Acquire training or expertise in handling equipment or chemicals, if necessary. Identify and obtain any required equipment, personnel, resources, and safety equipment for your program.

Fourth, implement your program. Unanticipated problems or concerns may force you to alter strategies. In that case, repeat the decision process incorporating the new information.

Fifth, monitor consequences of your program. Determine whether your desired goals are being achieved and whether there are any unexpected negative consequences. Continue to evaluate the program until the resource is no longer vulnerable, or conditions warrant terminating the program.

Problem Identification

A critical step in any program to successfully reduce forest resource depredation is to correctly identify the individual animal or species inflicting the damage. Animals presented below are generally recognized as species capable of inflicting severe damage to reforestation efforts or timber crops. These species are common in the forest and almost everyone can recognize them on sight. Unfortunately, the culprit is rarely seen. Therefore, the offending animal may need to be identified solely on the basis of the resultant damage. A brief description of the type of damage inflicted by each species is presented.

Mountain Beaver (*Aplodontia rufa*)

Mountain beavers clip seedlings and tree branches up to an inch in diameter (Figure 1). Their diagonal cut is typical of rodents, but multiple bites may create a serrated edge. Larger trees suffer basal barking and undermining of roots. Girdling by mountain beavers can be readily distinguished from bear girdling because the damage is lower on the bole and mountain beavers leave horizontal tooth marks and irregular claw marks. Further, bark strips will not be found lying at the base of the tree. Burrow systems of mountain beavers are usually present. Fresh digging, or fresh vegetation and debris near burrow entrances, indicate an active system.

Beaver (*Castor canadensis*)

Beavers may be destructive to waterways and forest resources. Flooding of roads and timber stands from blocked waterways is generally more detrimental than tree cutting. Tree cutting and barking, however, has

increased substantially during the last few years in the Pacific Northwest. Conical-shaped stumps and large wood chips at the base of stumps are good

indicators of beaver damage (Figure 2). Peeled sticks with uniform horizontal toothmarks are also generally found in the vicinity of beaver activity.

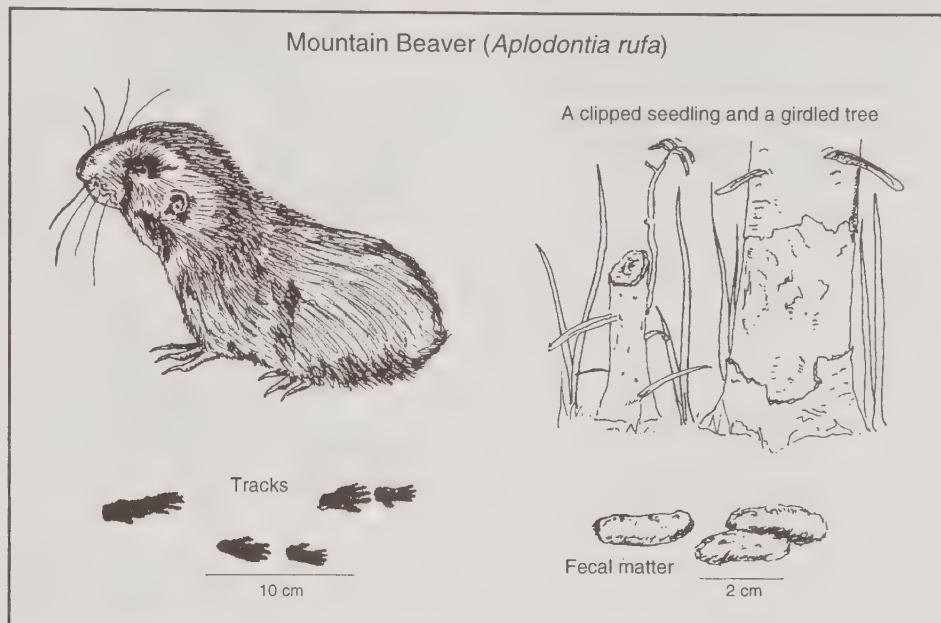


Figure 1—A mountain beaver and its characteristic signs.

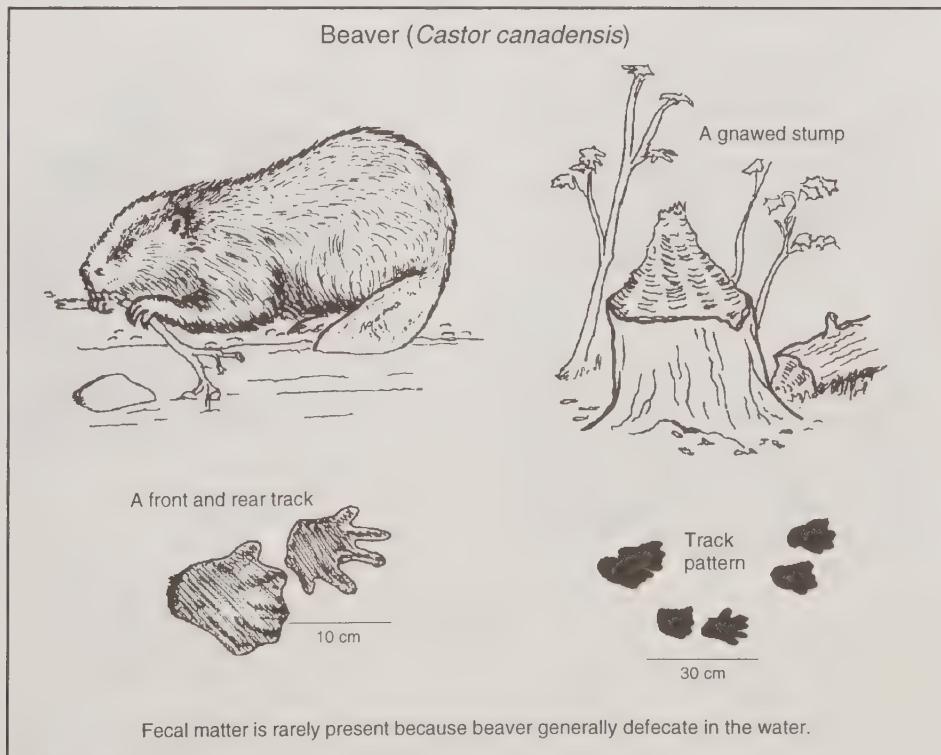


Figure 2—A beaver and its characteristic signs.

Elk (*Cervus spp.*)

Big game species, such as elk (Figure 3) and deer, inflict the most widespread form of damage to forest resources. Elk may pull newly planted seedlings or seedlings without well-established root systems out of the ground. Browsing elk often splinter woody stems. During the spring, the stems may be stripped of bark below the break. Elk also trample seedlings.

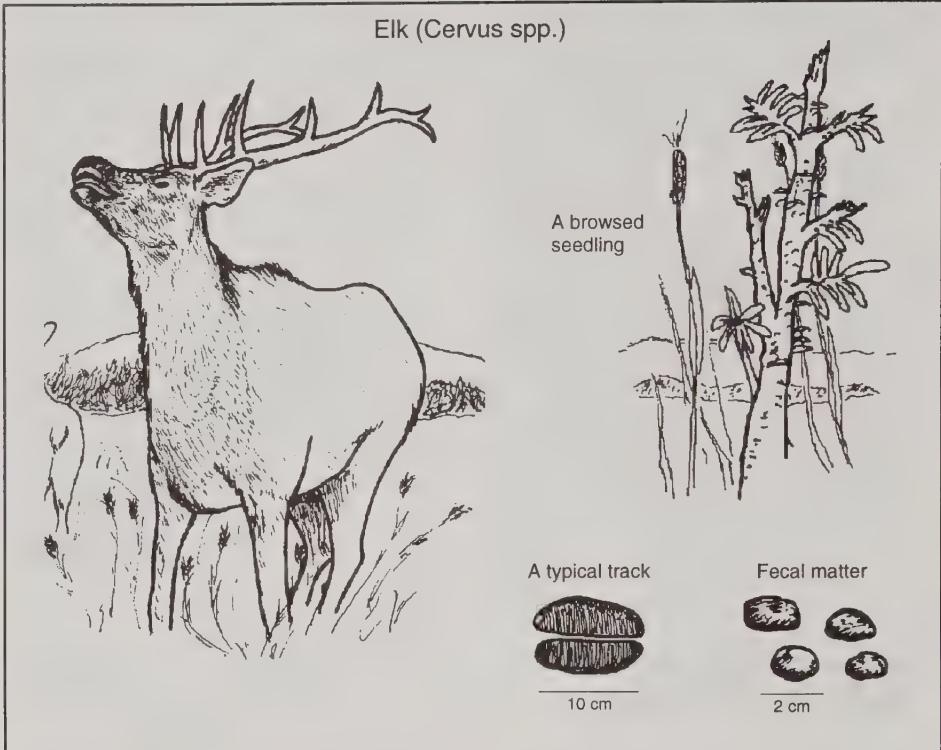


Figure 3—An elk and its characteristic signs.

Porcupine (*Erethizon dorsatum*)

Porcupines usually forage on young to pole-size trees. However, they may damage trees of all ages. Porcupines strip bark and clip branches of young trees (Figure 4), or forage among the tops of older trees. Branches are generally clipped at a 45° angle, with horizontal and blunt tooth marks (1/8 inch) along stripped branches. Prime indicators of porcupine activity are bark chips, clipped needles, quills, and fecal material at the base of damaged trees. Porcupines may also girdle the base of trees. During the winter, porcupines leave noticeable trails in the snow as they travel between trees.

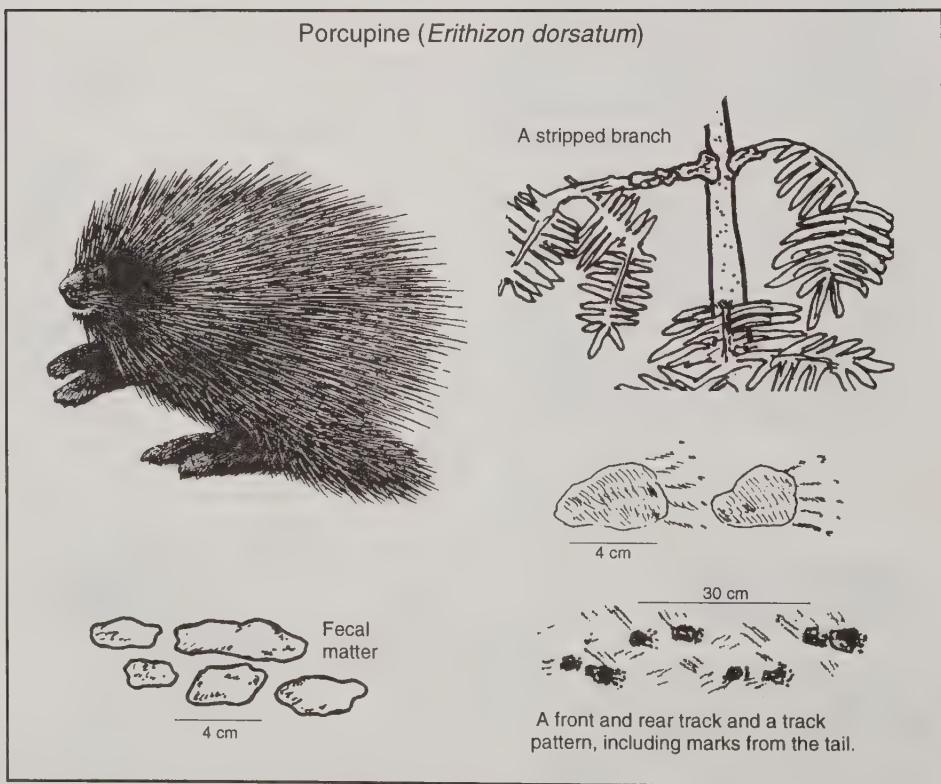


Figure 4—A porcupine and its characteristic signs.

Snowshoe Hare (*Lepus americanus*)

Snowshoe hare damage is difficult to distinguish from mountain beaver damage. An oblique, 45° angle cut is generally present on clipped seedlings (Figure 5). Snowshoe hares tend to prefer feeding on seedlings less than 1/4 inch in diameter. The most conspicuous signs of snowshoe hare activity are their tracks and fecal pellets left throughout the damaged site.

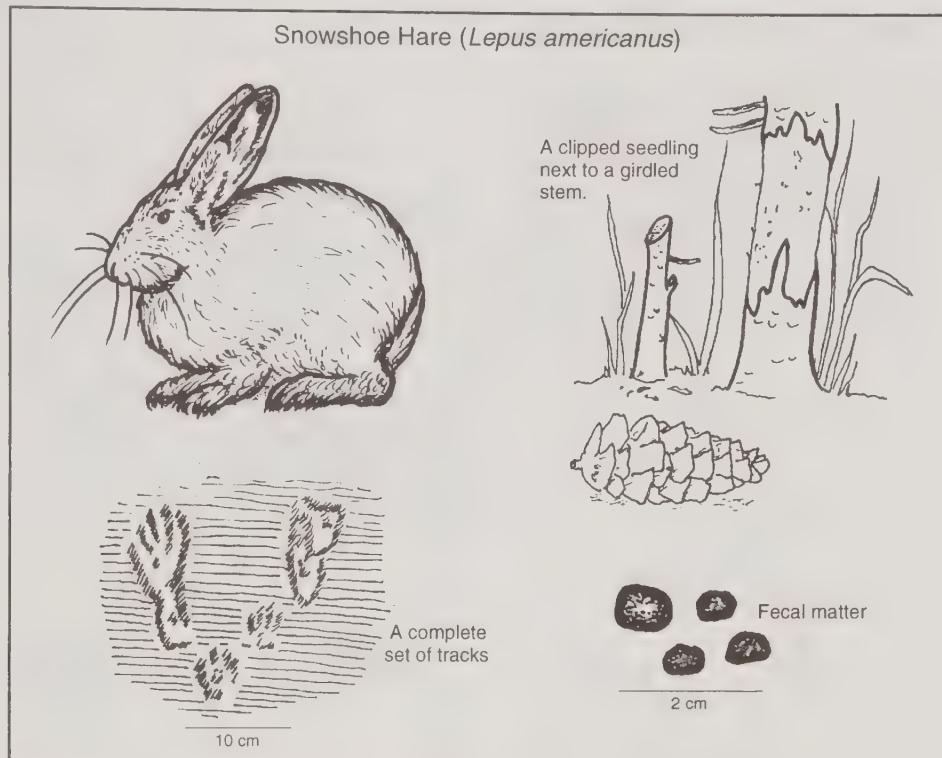


Figure 5—A snowshoe hare and its characteristic signs.

Vole (*Microtus spp.*)

Vole damage, like damage caused by most other forest rodents, occurs predominately on young seedlings. Pointed stems on clipped seedlings, and small whorled or circular marks on girdled seedlings are characteristic on seedlings clipped and girdled by voles (Figure 6). Root damage by voles is recognizable because voles generally strip the root and leave pointed tips. Where voles are active, there are distinct trails and intermittent open burrow holes.

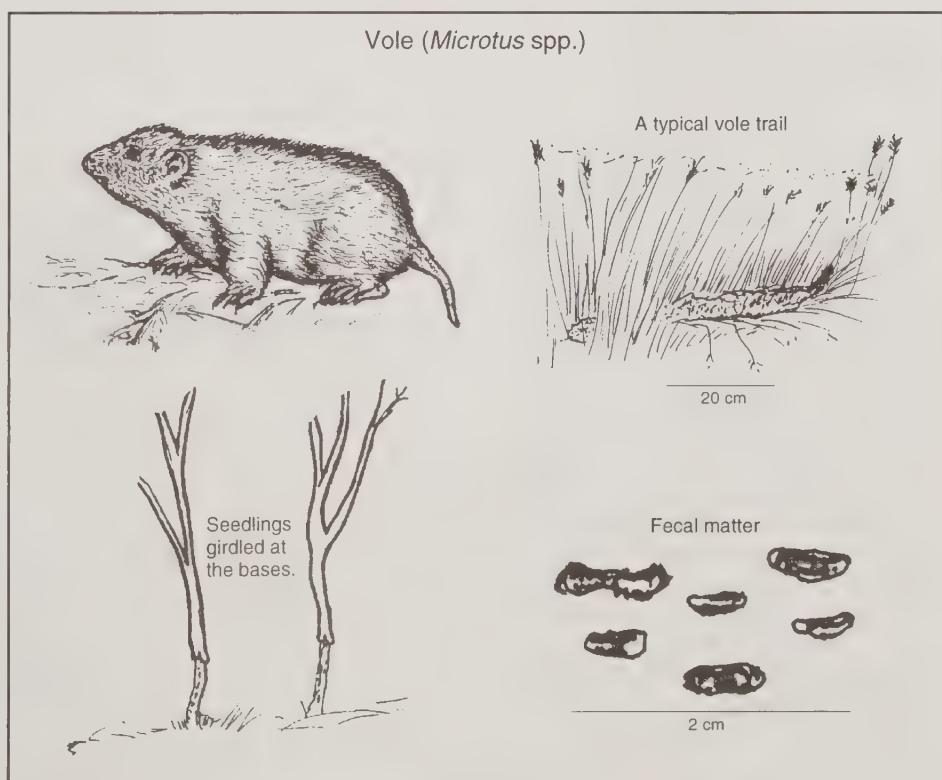


Figure 6—A vole and its characteristic signs.

Deer (*Odocoileus* spp.)

Deer damage inflicted on seedlings is similar to elk damage. Woody stems are often splintered and the bark is stripped from twigs (Figure 7). New buds are generally clipped back to the previous year's growth in the spring. Deer do not pull seedlings as frequently as elk and their damage rarely occurs above 6 feet.

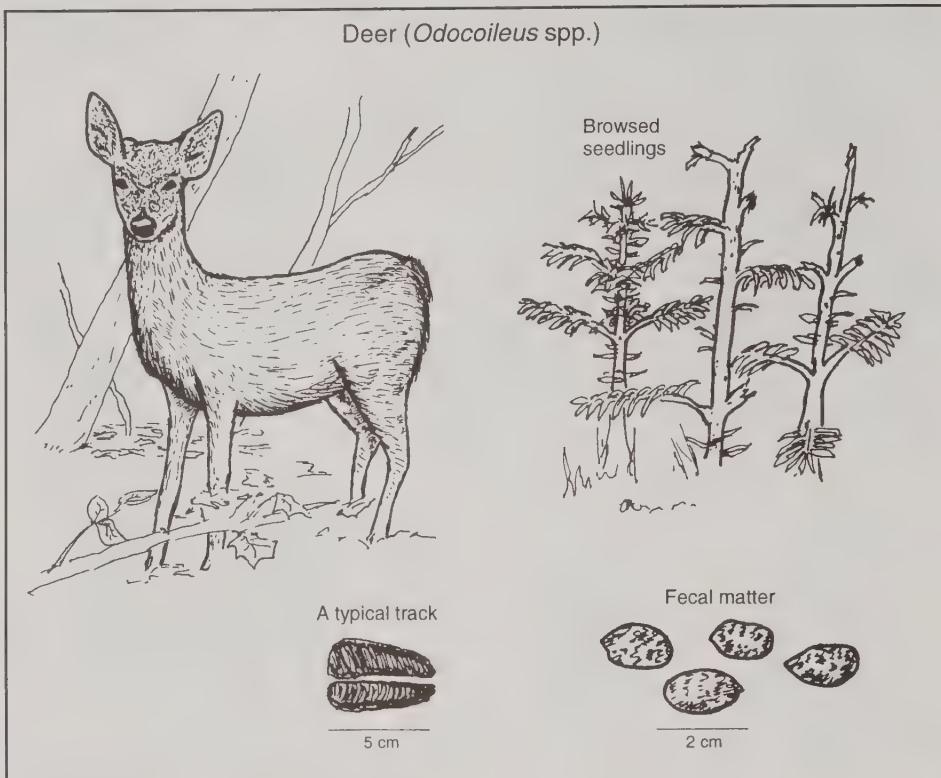


Figure 7—A deer and its characteristic signs.

Pocket Gopher (*Thomomys* spp.)

Pocket gophers commonly prune seedling roots, and girdle or clip seedling stems. Small seedlings, less than 1/2 inch in diameter, are the most vulnerable. The stems are clipped at or near ground level (Figure 8). Pocket gophers may pull the harvested seedling into their burrows. Pocket gophers also prune the roots and girdle the stems of larger trees. Extensive aboveground girdling of larger trees occurs under deep snow conditions. Aboveground girdling is fairly easy to detect. Damage to roots, however, may go unnoticed until seedlings tip over or become discolored. Nonlethal damage causes poor overall growth, shortened needles, reduced internodes, premature needle drop, and needle discoloration.

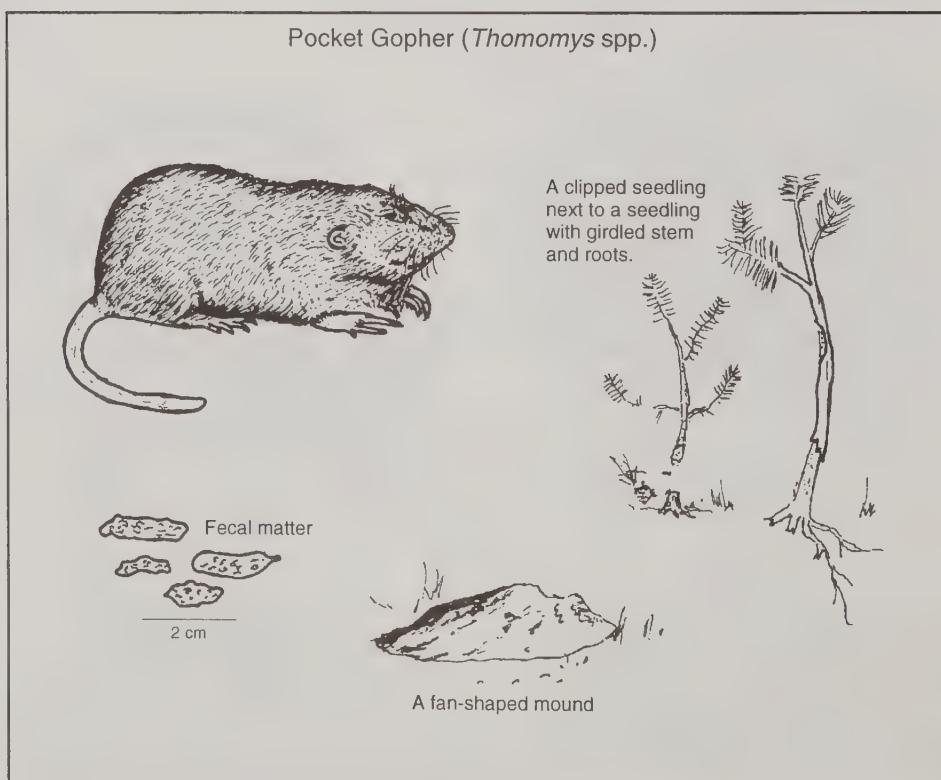


Figure 8—A pocket gopher and its characteristic signs.

Black Bear (*Ursus americanus*)

Bear damage occurs in the spring as bears become active and foraging opportunities are limited. Timber stands between 15 and 30 years of age are the most commonly damaged. Bears tend to select the more productive trees. Therefore, silvicultural practices that generate growth (e.g., thinning, fertilizing) may attract foraging bears. Bears generally feed on the lower bole of a tree (Figure 9), but occasionally an entire tree is stripped. They strip the bark with their claws and then feed on the sapwood by scraping it from the heartwood with their teeth. Trees damaged by bears have stripped bark lying at their bases. Vertical tooth and claw marks are generally visible.

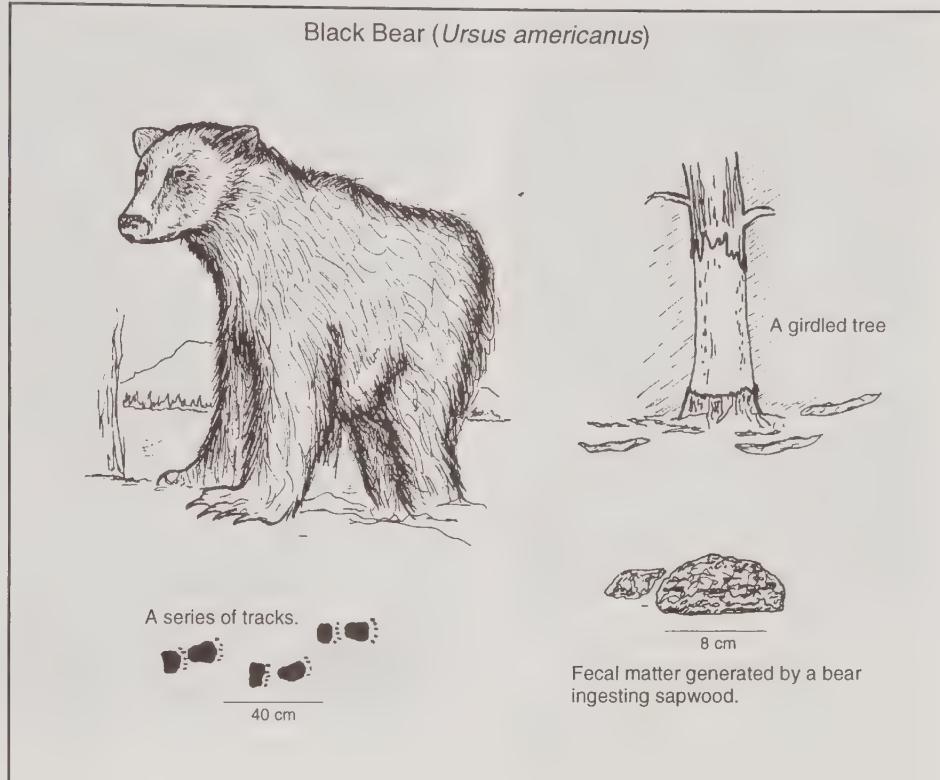


Figure 9—A bear and its characteristic signs.

Physical Deterrents

Physical deterrents impede animal access to specific trees or entry into reforestation plantations or nurseries. Deterrents vary from minor efforts to extensive construction projects. The most feasible approach depends on several economic, physical, and biological factors. The value of the resources to be protected, as well as the availability of resources to install a deterrent, also need to be considered.

The species and behavioral characteristics of the animal(s) inflicting the damage will dictate the physical traits of a deterrent. For example, a short compact barrier may protect a seedling from pocket gopher damage but provide no protection against deer browsing or antler rubbing. Conversely, an extensive fence may deter deer, yet fail to reduce damage by pocket gophers.

Consideration of seedling stem form may require that a barrier be removed or that it degrades within a specified time frame. Consideration should also be given to any negative effects a physical deterrent may have on nontarget species or on nondamaging behaviors of the target species.

Aesthetics may be a concern in some areas.

The most common methods of excluding animals are individual barriers, encircling an area with a fence, or covering resources with netting. Individual barriers are placed around each seedling or used to cover specific plant parts (e.g., terminal bud). A variety of tubes, bud caps, squirrel guards and obstructions are commercially available or easily constructed. Fences are constructed to prevent entry of foraging animals into specified areas. Drift fences are also used to alter animal movements away from a site or to encourage animals to move toward another control measure (i.e., direct porcupines along a fence into a box trap). Netting can be strung between posts to create a temporary fence or used as a cover for seedbeds to alleviate animal predation in nurseries.

Generally, physical deterrents are not hazardous to wildlife or humans. Prior to fence construction, the general area should be evaluated to ensure that physical barriers will not disrupt normal migratory patterns or exclude wildlife from limited resources, such as water or salt. Loose wires or openings in which wildlife could be ensnared need to be eliminated. Likewise, bird netting can be installed inside of tubes to prevent birds from entering and possibly being trapped in tall tubes. These considerations will not only decrease chances for detrimental effects to wildlife, but also greatly increase the longevity and efficacy of the structure.

The microclimate of seedlings may be altered by tubes. Seedlings within tubes will experience less wind than seedlings planted in the open. The restricted space and protective cover may also cause an increase in temperature, relative humidity, and soil moisture within the tubes. The amount and balance of solar radiation may also be altered.

The altered microclimate may have positive, neutral, or negative effects on the seedling's growth and health depending on the tube type, seedling size and condition, and environmental conditions. Less wind will reduce evaporation losses but will also favor height growth over stem girth, creating an unfavorable elongated seedling. Under cool climatic conditions, temperature increase in the tube will enhance growth. However, increased temperatures will suppress growth if the temperature becomes too hot, and may reduce hardening off during the fall. Increased relative humidity decreases evaporation losses, but also increases the likelihood of foliar diseases. Likewise, increased soil moisture favors growth, but too much soil moisture increases the seedlings susceptibility to diseases. Radiation, dependent on the tube, may be altered to a more favorable light balance to enhance photosynthesis or the tubes may create a less favorable light balance or permit insufficient light for photosynthesis.

Individual Barriers

Tubes

Function: Entire seedlings or portions of their root systems or stems are surrounded by tubes to reduce herbivory by foraging wildlife (Figure 10).

Description: A variety of tubing styles are available. Vexar, a plastic mesh made from polypropylene or a polypropylene and polyethylene mixture, was one of the first tubes commercially available.

Currently, tubes are produced from a variety of materials, including cardboard, metal, paper, and plastics. The rate of degradation of a tube will depend largely on the type of material from which it is constructed. Both tube color and placement (e.g., shade versus sunlight) will affect the photodegradation rate of plastic protectors. Dark colors, however, tend to degrade more slowly than light colors. The goal is to select materials that are strong and last long enough to provide the desired protection but degrade before they interfere with tree growth.

Tube walls may be solid or a mesh with diamond, twill, or square patterns. The twill and square patterns are flexible and easy to compress for easy transport. The rigidity of the diamond mesh and solid tubes enables them to withstand more abuse by animals. Solid tubes (Figure 11), or tubes with finer mesh sizes, reduce the likelihood that terminal and lateral buds will grow through the mesh or become entangled. Terminal buds outside the tube are vulnerable to herbivores. Tree deformities may develop if terminal buds catch on the sides of a tube. Protruding leaves and lateral branches are likely to be damaged.

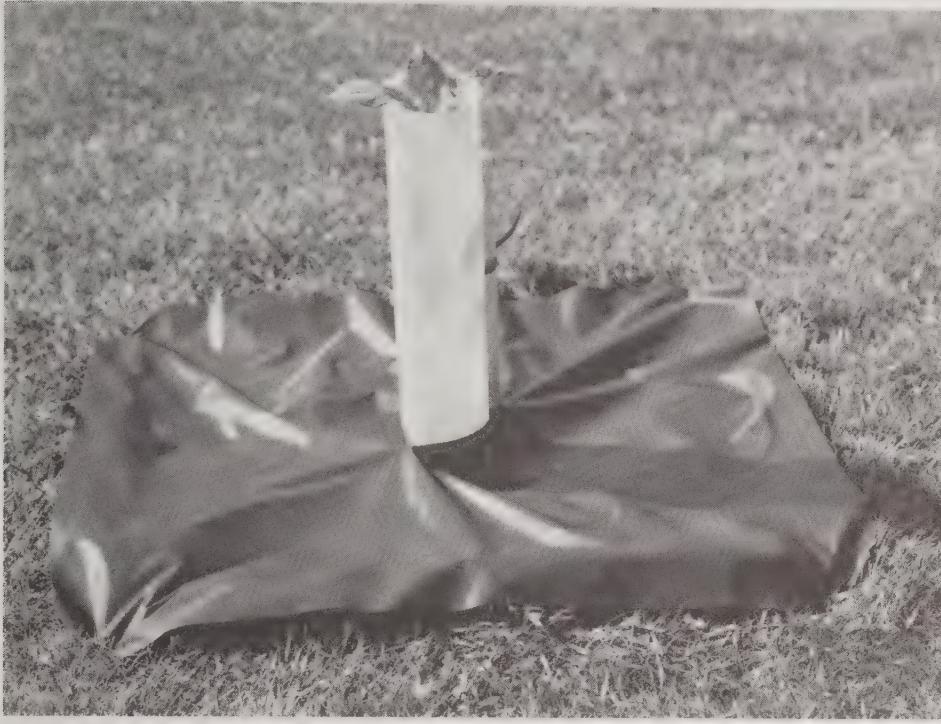


Figure 10—Seedling enclosed within a solid barrier.

Preferred tube size will depend on the species and age of the tree being protected, as well as the predatory species. Short tubes may deter pocket gophers, but tubes 5 to 6 feet long are normally recommended to prevent deer and elk damage. The extended length allows terminal growth beyond normal deer and elk browse height. Tube diameter needs to be adequate to permit tree growth. Small tubes, however, may provide better protection from burrowing animals and generally cost less. Tubes 2 to 3 inches in diameter are generally recommended for Douglas fir and western larch, while 4- to 6-inch diameter tubes are generally recommended for pine and hardwood seedlings.

Some type of support or anchor is usually attached to keep tubes upright. Supports come in all sizes and shapes and are constructed from a variety of materials (e.g., plastic, wood, metal). Spiral stakes anchor more firmly in the ground than do straight stakes. Stakes with hooks are more readily fastened to the tubes. Some tubes come with attached ties or wires that can be easily fastened to supports. Support

mechanisms can often be purchased along with tubes. Again, the necessary support will depend on objectives and the animals in the area. Additional support for tubes to protect seedlings from gnawing pocket gophers is minimal because the tubes are usually short and buried a few inches in the soil. Tubes stationed in areas with ungulates, however, require substantial support. Ungulates knock tubes over when they rub against them and may pull the tube and seedling out of the ground. Metal fence poles are effective but expensive.

Operation: Tubes can be installed around seedlings either before or after planting. When installed prior to planting, a flexible plastic tube that closely matches the seedling height is wrapped around each seedling. Seedlings are then planted with a few inches of the tube below the soil surface to help anchor the tube. Difficulties experienced with this method include getting the tree planted in an upright position and at the proper depth. Other difficulties include firmly packing soil around the roots.

Tubes applied after planting are worked down over the seedling and then



Figure 11—Plastic sheets with slots that fasten together to hold the barrier in place once it is wrapped around a seedling. Barriers are supported with 1/2 x 1/2 inch wooden stakes.

anchors or supports are attached. Tubes split down the side can be opened for installation. The sides are secured once the tube is in place. Mesh tubes must be installed vertically with the leaders centered to reduce chances of the seedlings' terminal buds becoming entangled in the mesh. Supports should be placed immediately next to the tube.

Advantages: Properly installed tubes protect seedlings from most wildlife species. Tubes are not hazardous to humans or wildlife and they do not restrict wildlife access to other forage. Also, the reduced competition and the altered microclimate produced by some tubes may enhance seedling growth.

Disadvantages: Tubes are expensive and labor intensive to install. Large, solid-wall tubes require substantial space for storage and transport. Improperly chosen tubes, or tubes poorly installed, can cause seedling deformities or increase seedling mortality. The microclimate produced by some tubes may reduce seedling growth. Also, the high humidity in some tubes may increase problems with foliage diseases.

Sources:

ADPI Enterprises, Inc.
American Forestry Technology, Inc.
Davlyn Manufacturing Company, Inc.
Design Packaging
Forest Protection Products
Forestry Suppliers, Inc.
Naltex Plastics, Inc.
Norplex, Inc.
Orchard Supply Company
Pacific Western Container
The Tensar Corporation
Treesentials Company

Bud Caps

Function: Bud caps are placed over the terminal bud to prevent browsing by ungulates.

Description: Bud caps can be constructed from any lightweight material that will fold, such as waterproof paper, fine mesh netting, or short pieces of mesh tubing. Fold the selected material to form a pocket that is slipped over the terminal bud. The cap is then fastened together with staples.

Operation: Bud caps are slipped over the terminal buds and held together with staples. Center the terminal bud within the cap. As a precaution do not cover more than 25% of a seedling's foliage and make sure that the stem is of an adequate size to support the cap.

Advantages: Bud caps are relatively inexpensive and require minimum skill to apply.

Disadvantages: Bud caps can cause heat damage to terminal buds. Bud caps provide no protection from rodents and may be pulled off the seedling by deer and elk.

Obstructions

Function: Obstructions are used to inhibit access to trees by foraging wildlife.

Description: Obstructions can be anything that will serve as a barrier, such as tree limbs or forest debris.

Operation: Cover the seedling with debris, such that the debris does not interfere with tree growth but hinders access by animals. Seedlings may also be planted directly into existing debris.

Advantages: Implementation costs are limited to the expense of labor to construct obstructions.

Disadvantages: Obstructions provide protective cover for small mammals and may increase damage by rodents.

Squirrel Guards

Function: Squirrel guards discourage tree squirrels from climbing trees.

Description: A squirrel guard is a 2-foot collar of metal or plastic that encircles the base of a tree. The guard is fastened together with wire attached to springs to allow for tree growth.

Operation: The guard is fastened around the base of a tree approximately 6 feet above the ground.

Advantages: Tree guards are easy to install and work well to protect isolated trees.

Disadvantages: Unless squirrel guards are placed on all trees, they are generally ineffective in forests or wherever tree branches normally become entwined.

Exclosures

Fencing

Function: Fences exclude wildlife from the protected resources. Drift fences are also used to alter wildlife movements or direct them to other damage reduction methods, such as traps.

Description: A vast array of designs and materials to construct fences exist. When selecting a fence design, consideration needs to be given to the overall objectives, soil types, vegetation, topography, maintenance requirements, availability and cost of materials, expected life span, labor, and visual impact. This section is not intended to serve as a comprehensive discussion on fence materials, design, or construction. For more detailed information refer to additional readings listed in the bibliography section. Fence designs and specifications are also available through the sources listed below.

Fences are commonly constructed of wire stretched between posts (metal or wood). The wire can be smooth, or barbed to restrict passage (Figure 12), or electrified to deliver a shock (Figure 13). Woven fences come in a variety of shapes and sizes. Historically, steel wire has been used to construct most fences. Plastics, however, are becoming more common. Wooden or metal rails also work, but are more expensive options.

Several designs for deer (Figure 14) and elk fencing have demonstrated some efficacy to prevent animal entry. Fences to keep out elk and deer should be a minimum of 8 feet and preferably 10 feet tall. Woven wires are much more effective at deterring ungulates than are strands of smooth or barbed wire. A combination of woven wire with strand wire installed immediately above it to provide additional height can be

effective. An electrified fence provides much better protection than a similar nonelectrified fence. Building a double or slanted fence adds depth, making the fence more difficult for ungulates to jump over. Flagging or other visible materials should be attached to make wire fences visible to prevent animals from running into them.

Woven wire (Figure 15) or solid fences are necessary to restrict rodent movements. The effective size of weave is dependent on the species of rodent. The bottom of the fence should be buried or fastened tightly to the ground to stop nonburrowing rodents. For burrowing rodents, such as pocket gophers and mountain beavers, the fence needs to be buried at least 3 feet below the soil surface. At the bottom the wire should be bent outward and upward, like a "J." The cup of the "J" needs to be approximately 6 inches wide with at least a 3-inch lip. The "J" is implemented because burrowing animals may dig downward along the outside of the buried fence. When they encounter the "J," it prevents them from continuing down and under the fence. An electrical wire or a slick sheet of metal (12 inches) fastened along the top will prevent most rodents from climbing over a fence.

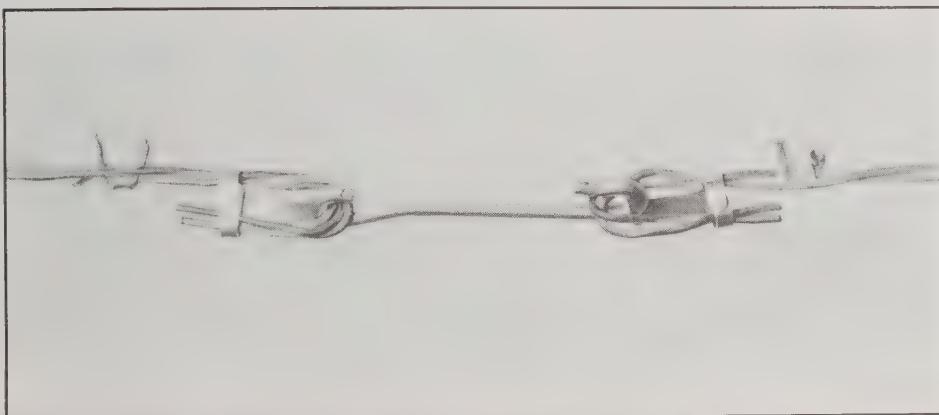


Figure 12—Strand of barbed wire spliced with the "Bull Wire Splice."

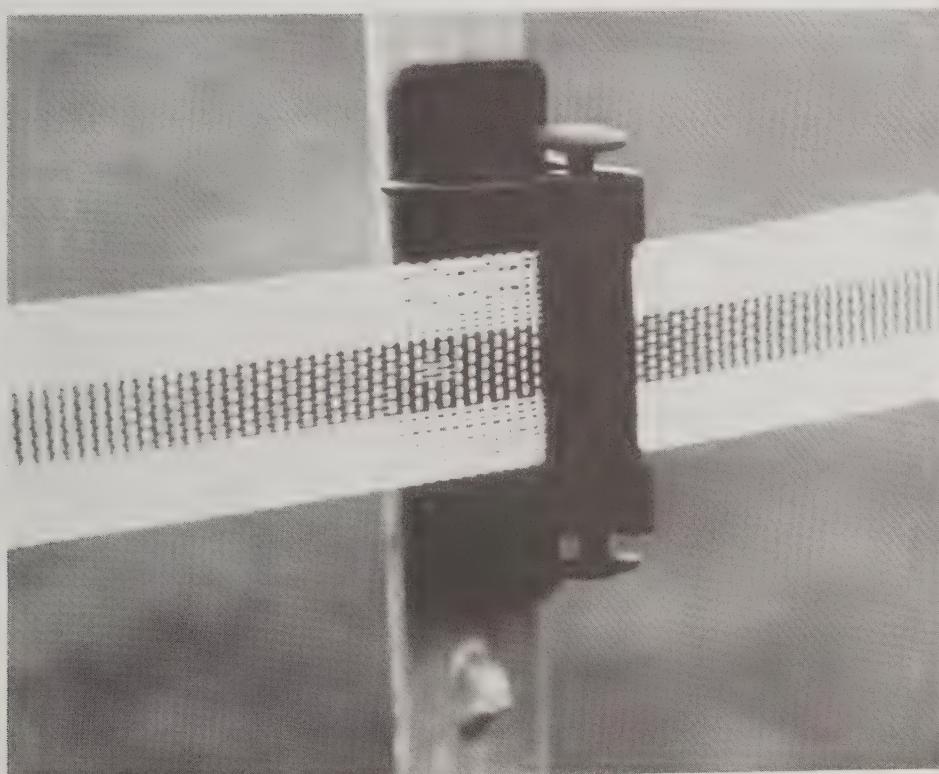


Figure 13—Closeup of "Super Wide Hot Tape" that can be strung between posts and electrified to protect agricultural products.

Operation: Steps to construct a fence will depend on the selected design. However, most operations will include the following steps:

1. Coordinate objectives and planning with all appropriate persons
2. Gather site information and select a fence design
3. Secure easements if necessary
4. Arrange for materials and labor
5. Locate fence line
6. Identify locations for posts, braces, and gates
7. Set corner, gate, and line braces
8. Set line posts
9. Attach insulators for an electric fence
10. Stretch wire
11. Attach markers to make wires more visible
12. Ground wire fences
13. Set gates
14. Set and attach the energizer for an electric fence.

Fences need to be checked regularly to determine if repairs are necessary. Broken wires and posts need to be replaced or mended. Burrows and holes dug by rodents along the fence will need to be collapsed and filled. Vegetation should be mowed or clipped along electric fence installations to keep weeds from grounding the fence.

Advantages: Once constructed, enclosures protect resources for a long time and can be very effective. Fences are generally not dangerous to the physical well-being of wildlife or humans.

Disadvantages: Construction and maintenance of fences are expensive and labor intensive. Fences exclude wildlife from habitat and may interfere with normal activity and migration patterns. Wildlife can injure themselves if they run into or become entangled in fences.

Sources:

ADPI Enterprises, Inc.
American Feed & Farm
Baygard-Bay Mills, Ltd.
Brookside Industries, Inc.
Conwed Plastics
Dairyland Power Fence Company
Gallagher Power Fence, Inc.
Geotek, Inc.
Grassland Supply
Keystone Steel & Wire
K Fence Systems
Kiwi Fence
Live Wire Products, Inc.
Margo Supplies, Ltd.
Mississippi Valley Forest Products, Inc.
Naltex Plastics, Inc.
Premier Fence Systems
Qual-Line Fence Corporation
Safe Shop Tools
Southwest Power Fences
Techfence-Advanced Farm Systems
Tenax Corporation
Twin Mountain Supply Company
United Textile Corporation
Waterford Corporation
West Virginia Fence Corporation
Wildlife Control Technology, Inc.

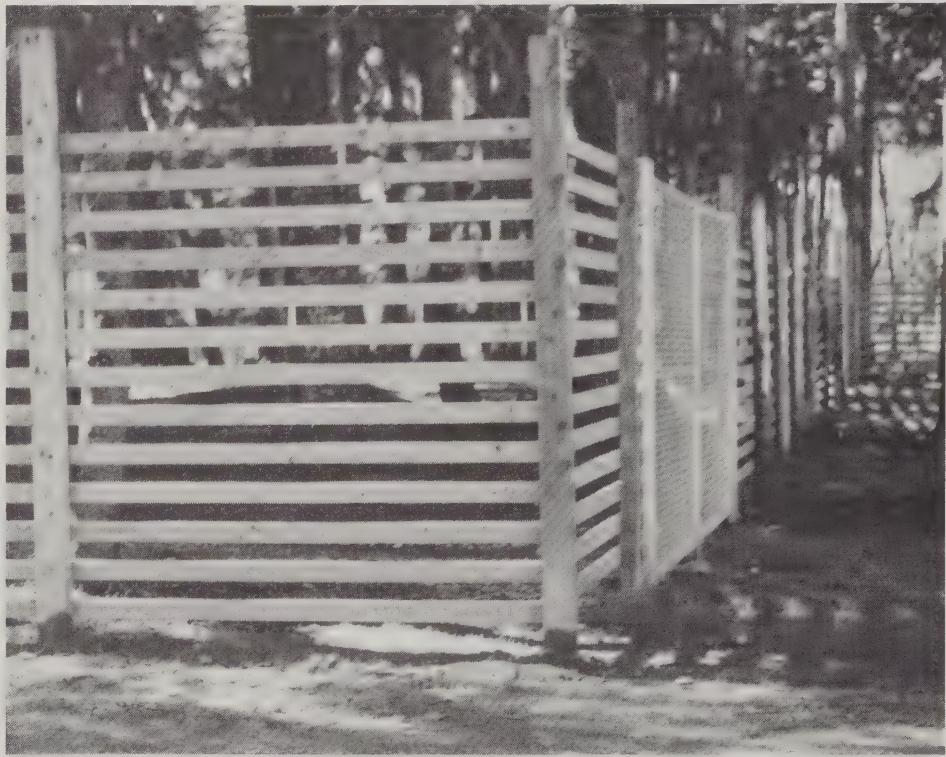


Figure 14—Wooden fence installed to inhibit deer access to seedlings.

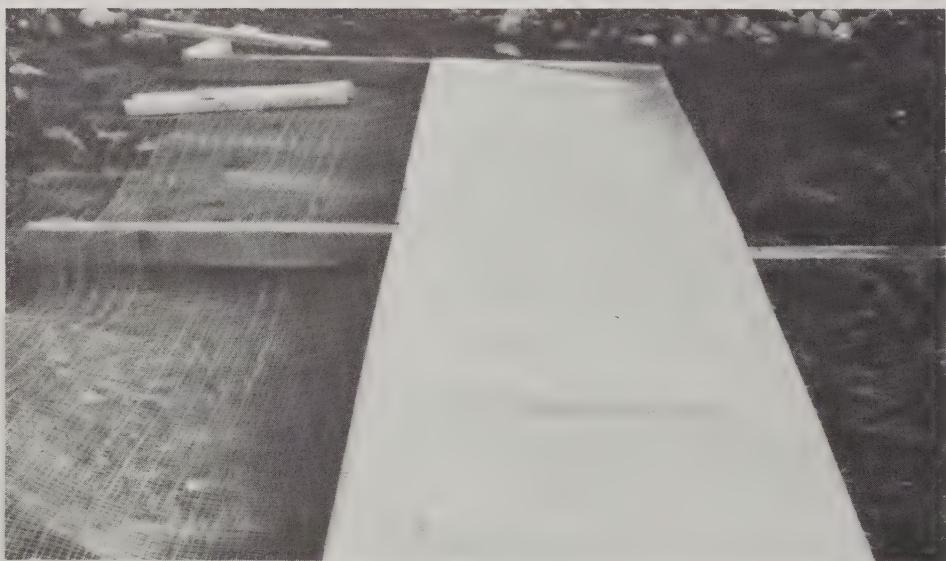


Figure 15—Rodent barrier constructed with metal aboveground and woven wire to extend 3 feet belowground when installed. Wire at the bottom will be bent to form a "J."

Netting

Function: Netting is used to construct temporary enclosures, or where conditions require less weight or more flexible materials than generally used for conventional fences (Figure 16).

Description: Netting comes in a variety of weave sizes and patterns. Netting is flexible; it easily bends around corners and conforms to surface contours. Plastic and nylon are the most common materials. Again, the most appropriate style and size of netting depends on the objectives and available resources. Literature available through either the sources listed below or in the bibliography section provides alternative designs and product specifications.

Operation: Procedures to install netting are similar to those described for fencing. Net fences, however, are lightweight

and are generally temporary. Supports need not be as durable or as strong as those used for conventional fences. Netting can be hung from metal fence poles to create a barrier for deer or elk. A wire or bar strung across the top will secure the upper portion of the net and prevent sagging. Another wire stretched along the ground or stakes can be used to secure the bottom of the net.

Ungulate and bird depredation of seed beds can be inhibited by hanging nets over supports to create tent-like structures. Poles can be used to support netting. A guide wire stretched along the top of the poles will prevent sags between poles and permits poles to be spaced further apart. A series of inverted U's constructed out of plastic pipe also work well to support nets. Drape the net over the supports and then pull it outward and stake the edges securely to the ground.

Advantages: Netting is less expensive and easier to install than conventional fencing. Netting can be easily removed once conditions or objectives change. Netting is flexible and will easily cover irregular surfaces or bend around corners.

Disadvantages: Netting is more easily torn and needs repairs more frequently than do conventional fences. Like fences, netting excludes wildlife from habitat and may interfere with normal migration patterns. Animals can become entangled in nets and injure themselves.

Sources:

ADPI Enterprises, Inc.
APGAR, Inc.
Birdbusters
Bird-X, Inc.
Blue Mountain Industries
C. Frensch, Ltd.
Conwed Plastics
E.I. Dupont DeNemours and Co., Inc.
Fuhrman Diversified, Inc.
Green Valley Blueberry Farm
Internet, Inc.
J.A. Cissel Company, Inc.
J.T. Eaton & Company, Inc.
Laird Plastics, Inc.
Margo Supplies, Ltd.
Miller Net & Twine
National Netting, Inc.
Nichols Net & Twine Company, Inc.
Nylon Net Company
Orchard Equipment & Supply Company
Prosoco, Inc.
Sinco, Inc.
Smith & Hawken
Specialty Ag Equipment
Sutton Ag Enterprises, Inc.
Tenax Corporation
United Textile Corporation
Wildlife Control Technology, Inc.



Figure 16—Netting over support posts to inhibit entry by wildlife species.

Traps

Trapping can be an effective means to remove animals that are damaging forest resources. Some trapping programs are selective in capturing specific individuals causing problems. Other trapping programs are implemented to reduce population densities of species that hinder reforestation efforts. These programs may be initiated after a problem is identified or in anticipation of problems on sites with high densities of species recognized as pests to forest resources.

The objectives of a trapping program will dictate the type and size of traps that should be utilized. In developing a trapping program several factors need to be considered, including the behavioral and biological characteristics of the target animal, ease of access to the trap site, experience and skill of the trapper, nontarget animals in the vicinity, cost effectiveness, state and federal laws and regulations, as well as other specific site considerations. Trap and release programs can be effective when specific individuals need to be removed.

However, release sites need to be identified prior to capture. Euthanasia procedures and equipment also need to be ready before a program is implemented.

State and Federal laws and regulations govern the treatment of wildlife. Prior to implementing a trapping program, check with the proper authorities to ensure that your program is legal. Generally, a State's Department of Wildlife is an appropriate place to contact for information and guidance on trapping regulations.

Most traps pose a minimum of danger to humans. However, caution should be exercised, particularly when children may encounter trap sets. Additionally, trapped animals are usually agitated. Depending on their size, they can be very dangerous. Trappers need to exercise caution to avoid injuries inflicted while setting some types of traps (e.g., body-grip traps) and while handling captured animals.

Live Traps

Box Traps

Function: Box traps are used for the live capture of small- and medium-sized mammals, such as squirrels or snowshoe hares.

Description: Box traps (Figures 17, 18, and 19) are generally rectangular or square, with swing door(s) hinged at one or both ends of the trap. Most box traps have a treadle located near the center of the trap floor that releases the swing door(s) when depressed. Box traps are commonly manufactured of welded wire mesh. Traps constructed of plastic, wood, and steel are also commercially available. Solid wall traps (Figure 18) are applicable where exposure to extreme weather conditions, predators, or curious humans is a concern. Appropriate trap size depends on the species of concern (Table 1).

Operation: Box traps are used for the live capture of most small- and

medium-sized mammals. These traps, however, have demonstrated limited efficacy for the capture of canines and felines. Because of their bulk, box traps are difficult to transport. The triggering mechanisms may restrict their use to level ground. Capture success is greatly enhanced if traps are placed at the entrance of burrows or dens, adjacent to or within burrows or runways, or in close proximity of food sources. Bait is used to entice the target animal into the trap. Stress to captured animals can be reduced by checking the traps frequently, covering the trap with plastic sheeting or burlap, and ensuring that food and bedding material is available within the trap to maintain the animal until it is released.

Advantages: Box traps are used to capture animals alive and unharmed. Subsequently, the operator can release, relocate, or euthanize the animal, depending on the objective of the operation. Therefore, these traps pose little threat to nontarget species. Durability of these traps varies. However, most traps generally withstand repeated use if they are well maintained.

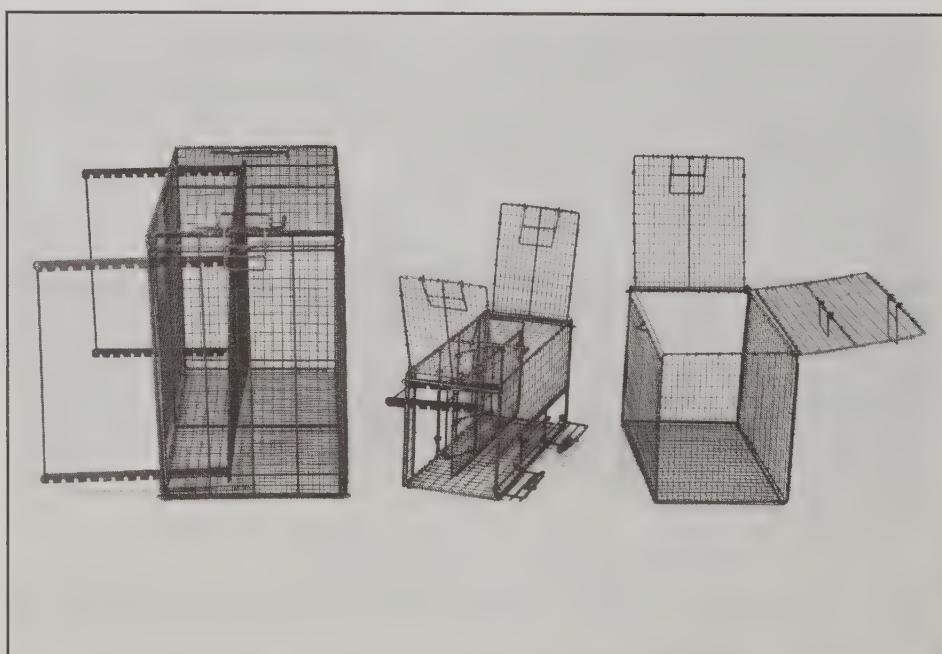


Figure 17—Several styles of box traps used to capture mammals.

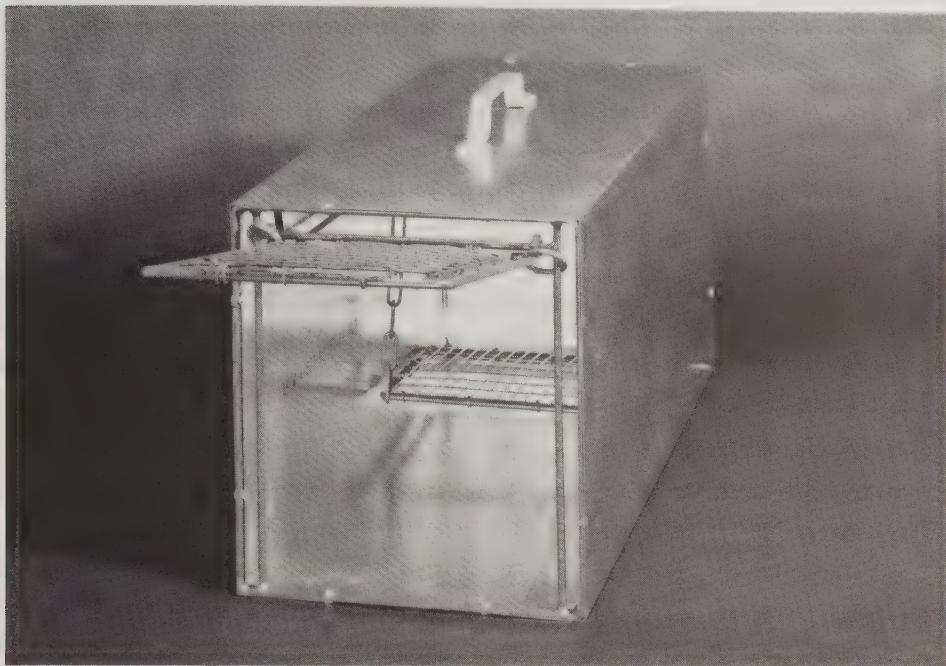


Figure 18—Box trap with solid metal sides used to capture medium-sized mammals.

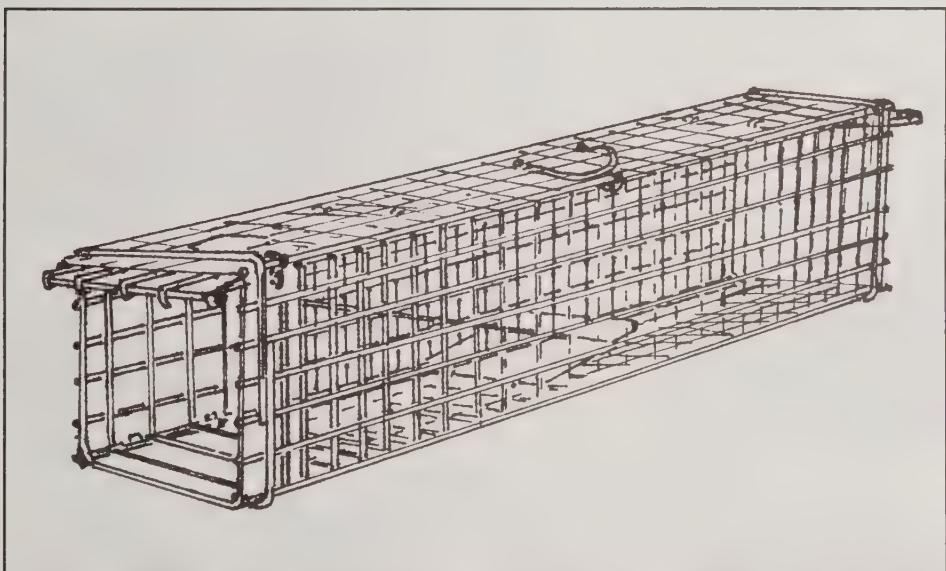


Figure 19—Modified Havahart trap specifically designed for the live capture of mountain beaver.

Table 1—Cage trap sizes that have been recommended for use to capture a selected list of representative mammals.

Mammal	Trap Dimensions	Mammal	Trap Dimensions
Ground squirrels	16" x 5" x 5"	Rabbits	32" x 9" x 9"
Rats	16" x 5" x 5"	Skunks	32" x 9" x 9"
Squirrels	19" x 6" x 6"	Opossums	32" x 10" x 12"
Squirrels	20" x 7" x 7"	Porcupines	40" x 12" x 12"
Muskrats	20" x 7" x 7"	Jackrabbits	42" x 15" x 15"
Mountain beavers	20" x 7" x 7"		

Disadvantages: Box traps are relatively expensive to purchase. Their bulk and weight make them difficult to transport. Trapped animals may injure themselves while attempting to escape or may undergo stress while in the trap. The size of traps hinders their versatility and does not readily permit them to be set on debris or uneven terrain.

Sources:

Animal Care Equipment & Services, Inc.
Animal Management, Inc.
B&G Chemicals & Equipment Co., Inc.
Bigelow Trap Company
B-Kind Animal Control Equipment
B.N. Bolton, Inc.
"Coon Getter" Traps and Animal Lures
Critter Control
Critter Gitters
Don Sprague Sales, Inc.
Duke Company
Ferrell and Company
Forestry Suppliers, Inc.
Goodart's
H.B. Sherman Traps, Inc.
J/J Fur Shop
Kemi-K Products, Inc.
Ketch-All Company
Krofick Outdoor Supply
Manufacturing Systems, Inc.
Minnesota Plasti-Catch
M&M Fur Company
Morrison Manufacturing Corporation
National Live Trap Corporation
Pioneer Wildlife Traps
R-P Outdoors
Safeguard Products, Inc.
Safety Live Trap
Seabright Enterprises, Ltd.
Stendal Products Inc.
Sterling Fur and Tool Company
Sullivan's Sure Catch Traps
Tomahawk Live Trap Company
Wickenkamp Live Trap Manufacturing
Woodstream Corporation

Suitcase or Clamshell Trap

Function: Suitcase- (Bailey) or clamshell- (Hancock) type traps are most frequently used for the live capture of stream beavers.

Description: These traps consist of two metal frames, connected together

at one side with coil spring hinges. The frames are covered with chain-link wire mesh. When set, they resemble an open or half-open suitcase (Figure 20) or clamshell. A lever extends from the coil springs into the center of the trap and triggers the release mechanism. Only one size is available (21 x 39 inches closed) and there are no factory options or modifications. Individual traps weigh between 20 and 30 pounds.

Operation: These traps are generally used for the live capture of stream beaver. However, these traps can also be used to trap other aquatic mammals (e.g., river otter). Traps are generally set in or above water level near a lodge opening, adjacent to a slide along the shoreline, or on a frequently used

runway. Placement of beaver traps near lodges may be regulated by law in some states. Captured beavers may drown if the trap is set such that a portion of the trap does not remain above the water surface. Baits may be used to entice the target animal into the trap. Commonly used baits include corn, poplar, willow or alder branches, and castor lures. Traps should be checked at regular intervals to reduce the risk of captured animals drowning or becoming hypothermic, and to allow the release of nontarget captures.

Advantages: Properly set and baited suitcase or clamshell traps are highly selective for live trapping stream beaver. Further, any nontarget animals that are captured can be safely released.

These traps are safe and pose little danger of injury to stream beavers, nontarget species, or humans when set properly and checked frequently.

Disadvantages: Suitcase and clamshell traps are expensive and their bulk and weight makes them difficult to transport. Trapping with these traps is labor intensive. Their size restricts their use to areas that are accessible by vehicle or boat.

Sources:

Critter Control Wildlife Mgmt. Supplies
Hancock Trap Company
M&M Fur Company
R-P Outdoors

Leg-Hold Traps

Function: Leg-hold traps restrain the leg of an animal and are used to capture a broad range of species.

Description: Leg-hold traps are small, spring-activated mechanical capture devices. They consist of a pair of jaws, one or more springs, a triggering mechanism, and a circular base onto which the jaws and springs are attached. When pressure is applied to the triggering device, the jaws spring shut, capturing the leg of an animal. All leg-hold traps are manufactured with steel or steel alloys and are available in many sizes (Table 2). Three basic types of leg-hold traps are commercially available:

1. Coil spring
2. Under spring, or jump trap
3. Long spring.

Coil-spring traps (Figure 21) are powered by two or more small springs built into the center of the trap. The integral design of the coil-spring trap reduces its size and profile, permitting better concealment. Under-spring traps are powered by a single, integral spring. Long-spring traps (Figure 22) are powered by one or two large external "hinge" springs. These external springs increase the size and weight of the

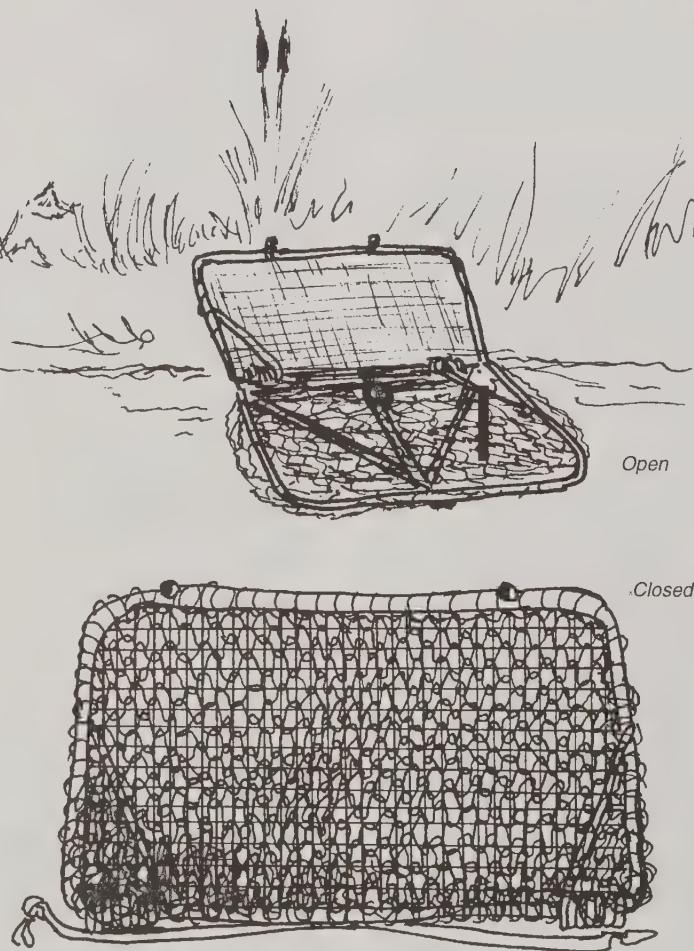


Figure 20—Suitcase traps used to capture beaver.

long-spring trap. Leg-hold traps have been frequently modified or reconfigured to improve the perceived humanness of the trap or to enhance its ability to catch and hold an animal. Common modifications include offset jaws, pan tension devices to exclude

Table 2—Leg-hold trap sizes and jaw spreads that have been recommended to capture a selected list of representative mammals.

Mammal	Trap Size	Jaw Spread
Rats	#0	3.5"
Pocket gopher	#0	3.5"
Opossums	#1-#2	4" to 5.5"
Woodchucks	#1.5	4.75"
Skunks	#1.5	4.75"
Beaver	#4	5.5"

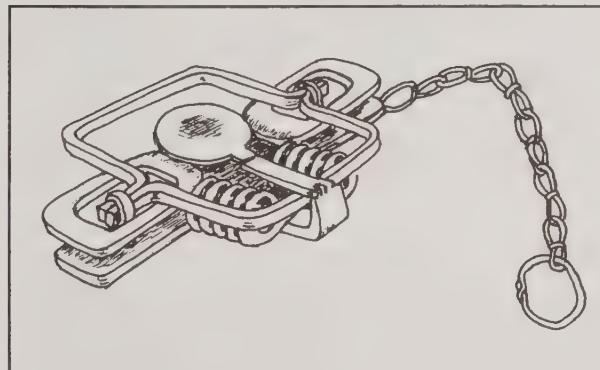


Figure 21—Coil spring leg-hold trap for the live capture of mammals.

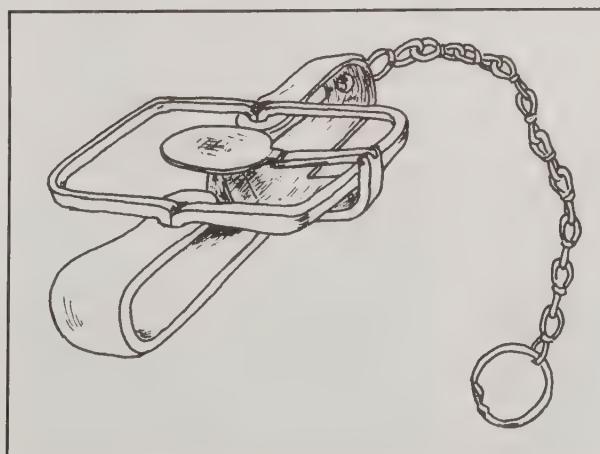


Figure 22—Long spring leg-hold trap for the live capture of mammals.

smaller animals, and various swivels or mounting devices for securing the trap, and altering the spring strength or padding the jaws.

Operation: Leg-hold traps are commonly used to capture a wide variety of mammals. Disturbance by nontarget species can limit the use of these traps in some areas. Several factors need to be considered for proper trap sets, including but not limited to: behavior of the target species, habitat conditions, and the presence of nontarget species. In terrestrial settings, unbaited sets may be placed in or near travelways frequented by target animals. Baits or lures may be used to attract the target animal to a trap set. Aquatic sets are most commonly made in shallow water near runways or adjacent to territorial marking sites used by the target animal. In general, coil-spring traps are used for smaller mammals in terrestrial settings, while long-spring traps are more commonly used in aquatic sets or for larger terrestrial animals.

Advantages: Leg-hold traps are significantly less expensive than cage traps. They cost substantially more than snares, however. Relative to cage traps, leg-hold traps are lightweight and small. Operators can transport 15 or more leg-hold traps, compared to one or two cage traps. These traps are generally durable, and replacement parts are readily available. A skilled trapper can place sets to minimize the incidental capture of nontarget animals. Generally, leg-hold traps permit the live release of nontarget animals. Human safety hazards associated with the use of leg-hold traps are minor.

Disadvantages: Leg-hold traps can inflict leg injuries to both target and nontarget animals. Injuries may result from the force of the trap or through efforts of the captured animal to escape. These injuries can be reduced by using offset or padded trap jaws, and by frequent checks of trap sets. Some expertise is required to effectively place trap sets and to minimize the risk of nontarget captures. The use of leg-hold traps is sometimes controversial and is banned in some states. Experience or training is required for leg-hold traps to be used safely and effectively.

Sources:

- Bigelow Trap Company
- Duke Company
- Ferrell and Company
- Goodart's
- Leggett's Supplies
- Manufacturing Systems, Inc.
- Minnesota Trapline Products
- M&M Fur Company
- Montgomery Traps, Inc.
- O'Gorman Enterprises
- Ranchers Supply, Inc.
- R-P Outdoors
- Sterling Fur and Tool Company
- Woodstream Corporation

Foot Snares

Function: Foot snares can be used to capture a wide variety of animals. They are the most common and effective means used to capture bears, particularly in remote locations.

Description: A foot snare generally consists of a wire lead that is looped through a locking device and attached to a swivel (Figure 23). Some foot snares may be powered by a device that throws the snare upward onto the animal's leg. The snare is generally fixed to a tree or other stationary object, or to a drag to minimize an animal's movement away from the capture site. The type and diameter of cable, cable length, and type of lock device depends on the target animal (Table 3). Nontarget injuries and captures can be limited by placing a stop on the lead to

prevent closure beyond that necessary to hold the species of concern, or by using a break-away lock or cable that releases when force is exerted beyond that expected from the target species.

Operation: Foot snares are used to capture a wide variety of animals. They are the most common and effective means used to capture bears, particularly in remote locations. Snares can be placed in or near pathways frequently traveled by the target animal, or used in conjunction with baits or lures to entice the target animal to the snare. Considerable skill and knowledge of

animal behavior is required to make effective sets.

Advantages: Snares are the least expensive type of capture system. Their compact size and light weight make them easy to transport. Most snares are durable. Broken snares can readily be repaired with inexpensive replacement parts. Snares pose minimal safety hazards to humans and nontarget species.

Disadvantages: Considerable skill is required to place effective sets. Though snares themselves pose minimal hazards to humans, captured animals have room to move and can inflict serious injury to intruders if approached too closely. This can be particularly dangerous if an animal has moved a drag set so the location of the animal is unknown. The use of snares may be regulated or restricted by law in some states.

Sources:

Grawes Animal Lures
Hoffman Trapping Supplies, Ltd.
M&M Fur Company
Rocky Mountain Wildlife Products
R-P Outdoors
The Snare Shop

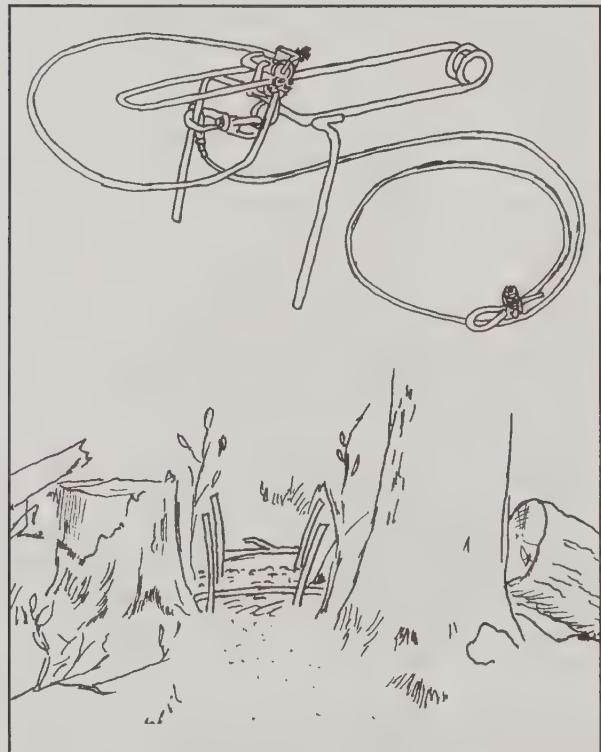


Figure 23—Foot snare attached to a spring; a typical foot snare set is depicted below.

Table 3—Snare sizes and cable sizes that have been recommended to capture a selected list of representative mammals.

Mammal	Snare Size	Cable Size
Squirrels	00-20"	1/32"
Rabbits	0S-30"	1/16"
Beavers	2S-40" to 2XX-72"	3/32"
Bears	5XX-120" to 6XX-120"	5/32" to 3/16"

Description: Body-grip traps consist of two rectangular wire jaws with strong coil springs on one or both sides of the trap (Figure 24). The trap is armed by spreading the jaws apart against the force of the springs, which are then held in place with a notched lever or dog. Attached to the dog is a wire trigger that extends to the center section of the set trap. When the trigger is moved, it releases the dog, allowing the trap jaws to rapidly spring shut. Animals are killed with a strong blow to the body, often breaking the neck or spine. Body-grip traps are manufactured by several companies, all of which make traps in a number of standard-sized models (Table 4).

Operation: Body-grip traps can be used for the lethal removal of most small- to medium-sized mammals. Accidental encounters are generally lethal or injurious. Therefore, the successful release of nontarget species is unlikely. Caution needs to be exercised to ensure that nontarget exposures are minimized. Use of body-grip traps may be restricted by law in some states.

Trap placement is similar to that used for live traps. In terrestrial settings, unbaited sets are placed in or near travelways frequented by target animals, or baits or lures may be used to attract an animal to a trap set. These traps are often placed in burrows to remove fossorial rodents. In aquatic settings, sets are most commonly made in shallow water near runways or adjacent to territorial marking sites used by the target animals.

Advantages: Body-grip traps are relatively inexpensive. Their cost is similar to or less than the cost of leg-hold traps. Their light weight and compact construction makes body grip traps easy to transport. They are generally durable. A skilled trapper can use body-grip traps to make selective captures, especially for fossorial and aquatic species. Most animals are generally killed in a quick and humane manner.

Lethal Traps

Body-Grip Traps

Function: Body-grip traps are designed for the lethal removal of animals. Death is usually quick, generally induced by breaking the neck or the spine of the captured animal.



Figure 24—Body-grip trap, and a cutaway of the trap set in a mountain beaver burrow.

Table 4—Body-grip trap sizes and jaw spreads that have been recommended to capture a selected list of representative mammals.

Mammal	Trap Size	Jaw Spread
Squirrels	110, 120	4-1/2" x 4-1/2"
Mountain beavers	110, 120	4-1/2" x 4-1/2"
Rabbits	120	4-1/2" x 4-1/2"
Skunks	120, 160, 220	4-1/2" x 4-1/2", 6" x 6", 7" x 7"
Opossums	120, 160, 220	4-1/2" x 4-1/2", 6" x 6", 7" x 7"
Porcupines	220, 330	7" x 7", 10" x 10"
Beavers	220, 280, 330	7" x 7", 8" x 8", 10" x 10"

Disadvantages: Body-grip traps do not allow for the selective release of nontarget animals. Therefore, caution must be exercised to avoid the capture of nontarget species. If a trap is improperly set, or is sprung by a nontarget animal, the trapped animal may sustain sublethal injuries and will need to be euthanized by the trapper.

voles; the larger, heavier (rat) traps can be used to capture chipmunks and squirrels, as well as rats. The Museum Special trap was designed by small mammal collectors to prevent skull damage and is effective for the capture of intermediate-sized rodents.

Body-grip traps pose substantial risk of injury for an untrained operator.

Sources:

Bigelow Trap Company
Blue Mountain Industries
Critter Control
Duke Company
Mitying Development
M&M Fur Company
Pioneer Wildlife Traps
R-P Outdoors
Woodstream Corporation

Snap Traps

Function: Snap traps are used for the lethal removal of small mammals.

Description: Snap traps (generally used for rats or mice) consist of a wire frame jaw attached to a wooden or plastic base, and powered with one or two coil springs (Figure 25). The trap is set by opening the jaw and securing it with a wire hook attached to a trigger. Movement of the trigger releases the jaw, pinning the animal between the jaw and the plate. Snap traps are commonly available in two sizes. The small (mouse) size is suitable for the capture of mice, shrews and

Operation: Snap traps are most commonly used to control commensal rodents in and around residential, agricultural, and industrial buildings. However, they are also used to capture small mammals in field situations. Traps are generally set on the ground or on a flat surface. Animals are enticed to the trap by bait placed on the trigger. Peanut butter mixed with oats, apple, raisins, or bacon is an effective bait for most rodents. Larger snap traps can be mounted vertically on a tree (pan downward) to capture squirrels. Traps used in damp environments must be treated with lacquer or wood sealer to avoid rapid deterioration. These traps also require careful cleaning and maintenance after each use. Risk of nontarget capture of birds may be reduced by enclosing traps within a shelter.

Advantages: Snap traps are the least expensive type of trap. They are lightweight and are easily transported. Most target animals are killed in a quick and humane manner. Human safety risks are minimal.

Disadvantages: Snap traps do not allow selective release of nontarget animals. Therefore, caution must be exercised in their use to avoid the capture of nontarget species. A captured animal may sustain sublethal injuries and will need to be euthanized. Snap traps are not very durable and wear out with repeated use.

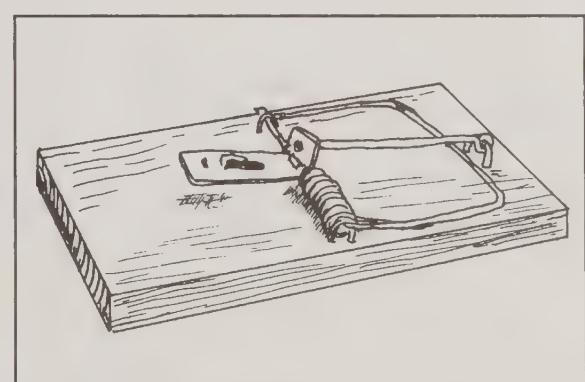


Figure 25—A snap trap used for small rodents.

Sources:

B&G Chemicals & Equipment Co., Inc.
Critter Control
GMK Company
Gremar Company
Guardian Trap Company
Hadley Products Company
Ketch-All Company
Kness Manufacturing Company, Inc.
McGill Metal Products Company
Micro-Gen Equipment Corporation
M&M Fur Company
Pest Control Supplies
P-W Manufacturing
Rodent Control Systems, Inc.
R-P Outdoors
Woodstream Corporation

Pocket Gopher Traps

Function: Pocket gopher traps are specifically designed for the lethal removal of pocket gophers.

Description: Two general types of pocket gopher traps are commercially available, the box choker (Figure 26) and pincher traps (Figures 27 and 28). The box choker trap is basically a snap trap enclosed within a box that has one end open. Bait may be used to attract a pocket gopher to the rear of the box. A wire frame jaw, released when the trigger located at the far end of the box is moved, pinions the animal to the base of the box. Pincher traps, such as the Macabee, have two jaws (or a wire loop and one jaw) that close together to pinion the pocket gopher. Jaws may be pointed inward to kill the animal more quickly.

Operation: Traps are placed within active pocket gopher burrows where fresh mounds or plugs are indicators of recent activity. Bait is generally not used with pincher trap sets. Slight openings to the surface behind a trap

set can entice a pocket gopher to the set when it attempts to plug the hole.

Advantages: Pocket gopher traps, relative to most other traps, are inexpensive. They are small and light, so an operator can readily carry a substantial number of them. Most are durable and can be used repeatedly. Nontarget animals are generally not a concern, since traps are set within active pocket gopher burrows. Pocket gophers are killed quickly and humanely. Risks to humans are minimal.

Disadvantages: Pincher traps do not permit the release of nontarget captures. Effective trap sets require training or an experienced operator. Pocket gopher trapping on large areas is labor intensive.

Sources:

Don Sprague Sales, Inc.
F.B.N. Plastics
P-W Manufacturing
R-P Outdoors
Wilco Distributors, Inc.
Windear Manufacturing Company
Z.A. Macabee Gopher Trap Company

Neck Snares

Function: Neck snares (Figure 29) are used for the lethal capture of animals. Neck snares can also be used to capture animals alive if a stop is placed on the snare to prevent closure.

Description: Snares generally consist of a cable lead that is looped through a locking device and attached to a swivel. When an animal is captured, the loop tightens as pressure is applied against the cable. The cable diameter and length vary with the intended use and the target animal (Table 3). Nontarget

animal injuries can be limited by placing a stop on the lead to prevent closure beyond that necessary for the target animal, or through a breakaway system that releases if a force is exerted beyond that expected from the target animal.

Operation: Snares can be used to capture a variety of mammals. Sets are placed along paths frequented by the targeted animal or are used in conjunction with baits. Considerable skill and knowledge of animal behavior are required for effective sets and to limit nontarget encounters. Captured animals are asphyxiated. The loop tightens around the animal's neck and death generally occurs within minutes. Aquatic trap sets are generally placed such that the animal is held beneath the water.

Advantages: Snares are the least expensive type of trap. Their compact size and light weight make them easy to transport. Most snares are very durable. Broken snares can be readily repaired with inexpensive replacement parts. Human safety hazards are minimal.

Disadvantages: Neck snares may not permit the release of nontarget captures. Considerable skill is required to use neck snares effectively and to minimize risks to nontarget species. The use of these devices may be highly regulated or prohibited by law in some states.

Sources:

Blue Mountain Industries
Grawes Animal Lures
Hoffman Trapping Supplies, Ltd.
M&M Fur Company
Rocky Mountain Wildlife Products
R-P Outdoors
The Snare Shop
Woodstream Corporation

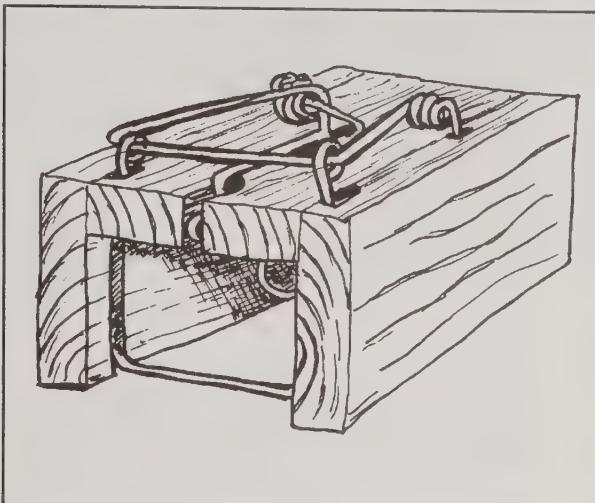


Figure 26—A set pocket gopher box choker trap.

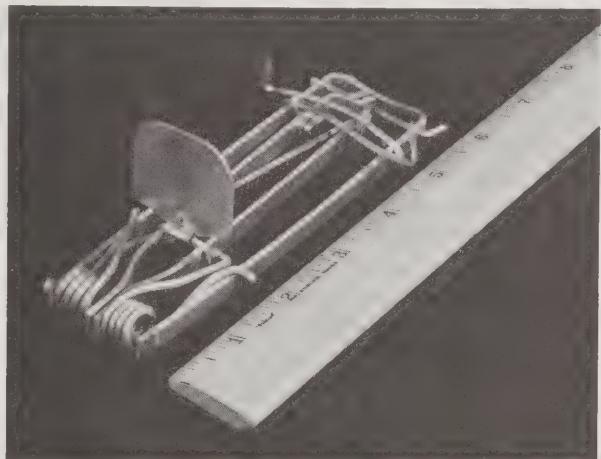


Figure 27—One style of pincher trap used for pocket gophers.

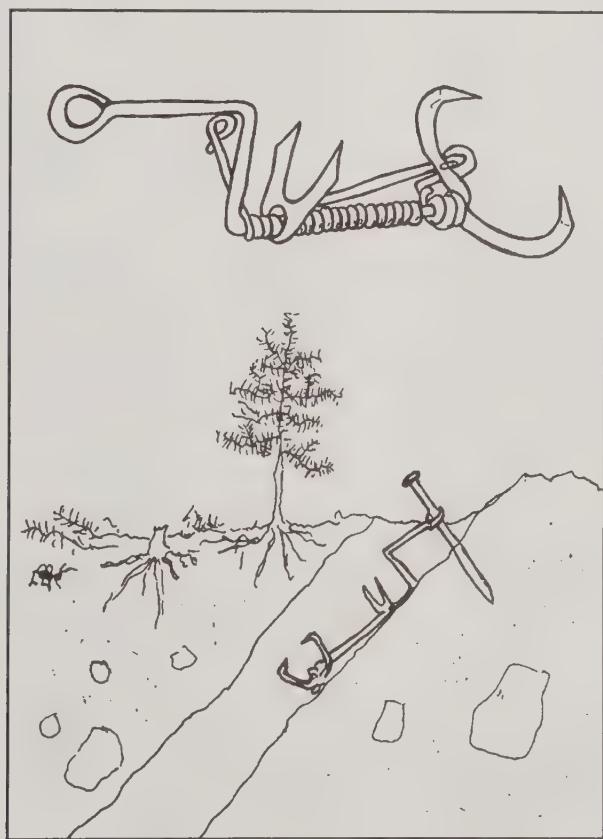


Figure 28—A pincher trap used for pocket gophers and a cutaway of a trap set in a pocket gopher burrow.



Figure 29—A neck snare and a typical neck snare set.

Toxicants

Toxicants can be an effective means of quickly reducing high populations of some problem animals, or of maintaining acceptable population densities. Generally, they are most applicable where existing or potential damage problems are related to population density. However, they may also be appropriate for treating areas with limited access or where other approaches have proven ineffective.

Toxicants are generally classified within one of three categories depending on their mode of action. Acute toxicants are ingested and are most often lethal soon after a single encounter. Chronic toxicants are also ingested, but are not immediately lethal. Fumigants are lethal gases that are injected into the burrows of the targeted species. The most applicable approach will be directed by your overall objectives and any restrictions regulating toxicants that apply to your specific situation.

Toxicants pose a potential hazard to the operator and other humans, as well as to nontarget species. Therefore, extreme caution needs to be exercised in handling, storing, and applying toxicants, and in disposing of waste materials. The applicator assumes responsibility to ensure that all legal and safety concerns are met prior to using toxicants. Carefully read and follow the restrictions and safety precautions provided on labels for each product. Federal and state registrations certify that it is legal to use the product according to the conditions and restrictions stipulated on the approved label. Registration does not guarantee the availability or the efficacy of a product. Rodenticides are commonly used to protect forest resources from depredation by pocket gophers (*Thomomys* spp.) and to a lesser extent by mountain beaver (*Aplodontia rufa*), voles (*Microtus* spp.) and woodrats (*Neotoma* spp.). At present, there are no toxicants registered for application in forest habitat to control beaver (*Castor canadensis*), porcupines (*Erethizon dorsatum*), squirrels (*Sciurus* spp.) or rabbits (*Sylvilagus* spp., *Lepus* spp.).

Toxicants are probably not feasible treatments for most nonrodent species that inflict damage to forest resources.

consumption. Mimic all procedures (e.g., bait location) that will be used in the subsequent program. Once untreated baits are being readily ingested by the target species, switch to the toxic bait.

Ingested Toxicants

Acute Toxicants

Function: Acute toxicants are used to quickly reduce populations of rodents.

Description: Single encounters with acute toxicants can be lethal to rodents. Death, depending on the toxicant, results from paralysis of the respiratory or central nervous system, cardiac failure, gastrointestinal irritation, hemolysis, destruction of kidney and liver tissue, or hypothermia.

Several acute toxicants are available, including strichnine and zinc phosphide. Strychnine induces paralysis of the central nervous system. Death occurs within 30 minutes if a lethal dose is ingested. The bitter taste of strichnine can hinder target animal acceptance of treated bait. Zinc phosphide produces phosphine gas when it reaches the stomach or intestines. The gas causes heart failure and liver or kidney damage. Symptoms generally occur within 30 minutes after intake and death occurs within 24 hours. Zinc phosphide has a distinctive garlic odor that may be attractive to some rodents at low concentrations.

Operation: Intake of lethal doses of toxicants by rodents can be problematic. Rodents may be hesitant to initially accept treated baits, or if sublethal doses are ingested, they may develop bait-shyness. Bait-shyness is a learned food aversion formed when a food is paired with gastrointestinal illness. Once bait-shyness occurs, the likelihood of subsequent intake is doubtful. Prebaiting can enhance the acceptance of treated baits. Before treatment, present untreated bait for target animal

The type of bait and its placement are important to the efficacy of a program to reduce populations of target species, and to minimize potential risks to nontarget species. Foods that are highly preferred by the target species and that do not spoil rapidly make the best baits. Most toxicants are available in ready-to-use baits (Figure 30). While this may increase the cost, it also reduces chances for accidental poisoning and incorrectly prepared baits.

Baits need to be placed in burrows or other locations where they will be repeatedly encountered by the target species yet not be readily available for nontarget species. Toxicants must be applied according to the regulations and restrictions on the applicable labels.

Advantages: A quick response can be expected with an effective program using acute toxicants. When delays in reducing rodent populations will result in extensive resource losses, acute toxicants may be the only reasonable alternative. Generally, acute toxicants are a relatively inexpensive means to reduce rodent populations. Single treatments require small amounts of toxicants and little labor to apply.

Disadvantages: Sublethal doses may induce bait-shyness, rendering a population reduction program ineffective. Prebaiting may be necessary, which enhances the efficacy but also increases the cost of a program. Acute toxicants are lethal to a broad spectrum of animals. Single encounters with these products can accidentally poison nontarget species.

Sources:

- Archem Corporation
- Bell Laboratories, Inc.
- B&G Chemicals & Equipment Co., Inc.
- Boehringer Ingelheim Animal Health, Inc.
- Bonide Products, Inc.

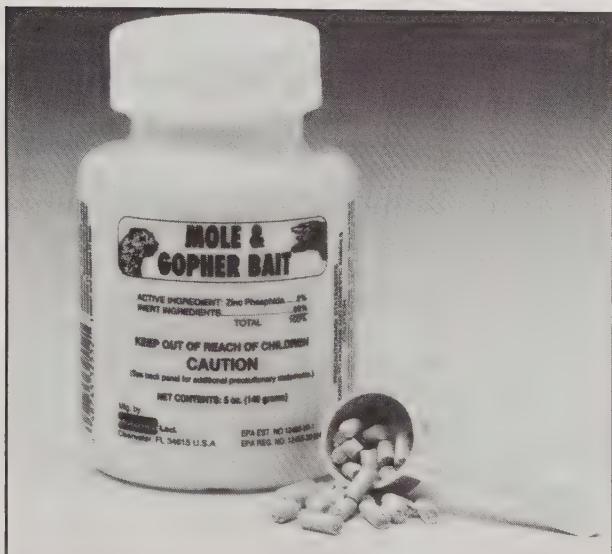


Figure 30—Mole and gopher bait.

Chas. H. Lilly
C. J. Martin Company
Eckroat Seed Company
Fort Dodge Chemical Company
HACO, Inc.
LiphaTech, Inc.
Monterey Chemical Company
Motomco, Ltd.
Nevada State Department of Agriculture
Nott Manufacturing Company, Inc.
Petersen Seeds, Inc.
Pocatello Supply Depot
Purina Mills, Inc.
RCO, Inc.
Rue R. Elston, Inc.
Sebesta Bait Mixing Plant
South Dakota Department of Agriculture
Southwest Chemical Company
VanWaters and Rogers
Wilbur-Ellis Company
Wilco Distributors
York Distributors

Chronic Toxicants

Function: Chronic toxicants are not immediately lethal to rodents, or lethal doses are generally ingested only after multiple encounters.

Description: Anticoagulants interfere with the production of vitamin K, which is essential for the synthesis of prothrombin and other factors

necessary for the natural clotting of blood. Inhibition of blood clotting, combined with the disruption of small blood vessels, causes fatal internal bleeding. The effects of most anticoagulants are cumulative. Lethal doses require repeated ingestion. Single-dose anticoagulants are not acute, since death occurs only after several days. However, like acute toxicants, they require only a single exposure. With single-dose anticoagulants, feeding stops

immediately. Death can occur after only 2 days. Though the mode of action for anticoagulants is relatively slow, they are reported to induce a painless death. Nontarget animals that have ingested anticoagulants can be treated with supplements of vitamin K, an effective antidote.

Anticoagulants belong to one of two groups, the hydroxycoumarins and the indandiones, which differ in chemical structure but are similar in their physiological effect. The hydroxycoumarin group includes brodifacoum and warfarin among others, while chlorophacinone and diphacinone belong to the indandione group.

Warfarin was the first anticoagulant developed. It is substantially more toxic when it is ingested over a period of consecutive days rather than during a single feeding bout. Bromadiolone was among a second generation of anticoagulants developed specifically to target warfarin-resistant rodents. Bromadiolone will induce death after a single feeding when high concentrations are ingested. Reduced concentrations are lethal after multiple feedings. Chlorophacinone and diphacinone are substantially more toxic than warfarin, but are not generally effective against warfarin-resistant rodents.

Cholecalciferol may be a single- or multiple-dose rodenticide. It causes calcium to mobilize from the bone matrix to plasma, which in turn induces hypercalcemia. After ingesting a lethal dose, an animal will quit eating. Death occurs within 3 to 4 days.

Operation: An effective program requires that multiple dose anticoagulants be ingested repeatedly over a period of time. Therefore, the bait should be readily acceptable and available for ingestion by the target species. Prepared baits with anticoagulants are commercially available. Bait stations ease repeated applications. Considerations for the operational application of chronic toxicants are similar to those for treatment with acute toxicants. Prebaiting, however, is not necessary because rodents generally do not develop bait-shyness to anticoagulants. Nontarget hazards are also less likely because single exposures are usually not lethal and antidotal treatment is possible.

Advantages: Chronic toxicants can be highly effective in reducing populations of target species. Hazards to nontarget species from a single encounter are slight and an antidote (vitamin K) is available. Anticoagulants are not likely to induce bait-shyness. Therefore, prebaiting is not necessary. The mode of action suggests an apparently painless death for the target species.

Disadvantages: Chronic toxicants may be effective only after being ingested on several subsequent encounters. Thus, populations of target species are not reduced as quickly with chronic toxicants as they would be with acute toxicants. Operational control with anticoagulants can also be expensive because of high labor input and the high cost of materials due to repeated baiting.

Sources:

Archem Corporation
Bell Laboratories, Inc.
B&G Chemicals & Equipment Co., Inc.
Boehringer Ingelheim Animal Health, Inc.

Bonide Products, Inc.
C.J. Martin Company
Ferrett Laboratories, Inc.
HACO, Inc.
J.C. Ehrlich Chemical Company
J.T. Eaton & Company, Inc.
LiphaTech, Inc.
Motomco, Ltd.
Nott Manufacturing Company, Inc.
Pest Control Supplies
Pocatello Supply Depot
Purina Mills, Inc.
RCO, Inc.
South Dakota Department of Agriculture
Southwest Chemical Company
VanWaters and Rogers
Wilbur Ellis Company
Wilco Distributors, Inc.
York Distributors

rodent burrows. Phosphine and carbon monoxide are two examples of fumigants. Aluminum phosphide reacts with atmospheric or soil moisture to release phosphine gas. Phosphine is colorless and produces only a slight odor, similar to that of carbide. Phosphine gas is dangerous at concentrations as low as 200 ppm (parts per million). At concentrations of 400 ppm, it is lethal to humans. At concentrations of 1000 ppm, a few breaths will kill humans.

Gas cartridges are incendiary devices that produce smoke and carbon monoxide when ignited. Concentrations of 200 ppm may induce symptoms of carbon monoxide poisoning within a few hours. Exposures to concentrations approaching 1000 ppm will induce death within 4 hours.

Operation: First, ensure that no nontarget species are present. Then check for and seal off all exits or porous areas where the gas may leak out. Smoke bombs are generally effective in locating numerous burrow openings. Once the systems are sealed, fumigants are inserted into the underground systems. Carefully read and follow instructions provided on the product labels.

Moisture content and soil particle size are important considerations for fumigation. Fumigants are most effective when the soil moisture is high and the soil temperature is greater than 60°F. Fumigation failures most frequently occur in dry, porous soils.

Extreme caution needs to be exercised when handling fumigants. They are lethal to all animals subjected to them. All restrictions and directions provided on the appropriate labels should be carefully followed.

Advantages: There are few advantages to using fumigants as a primary means to reduce populations of forest rodents. Fumigants may provide a feasible alternative when other measures are ineffective.

Disadvantages: Fumigants pose considerable hazards to nontarget animals that coexist in burrows with target species. They can also be extremely hazardous to the applicator. Operational use of fumigants is generally more expensive than other toxicants.

Sources:

Bernardo Chemicals, Ltd.
Degesch America, Inc.
Douglas Products and Packaging Co.
Nott Manufacturing Company, Inc.
Pestcon System, Inc.
Pocatello Supply Depot
Research Products Co.
Roxide International, Inc.
VanWaters and Rogers

Fumigants

Function: Fumigants (Figure 31) are used to produce a toxic atmosphere within the burrows of rodents.

Description: Fumigants are poisonous gases or compounds that produce poisonous gases. They are injected into



Figure 31—Fumigant pellets.

Applicator Equipment

Broadcast Applicators

Function: Broadcast applicators dispense baits over a wide swath.

Description: Hand broadcast spreaders or mechanical broadcast spreaders are commercially available. Most broadcast seeding equipment, with minor modifications, can be used to broadcast seed or pellet baits. Hand broadcasters consist of a storage bin, a crank-operated distribution device and an adjustable metering slot. The adjustable slot governs the rate of application. Mechanical broadcasters are similar to the hand-held versions, but have motorized components.

Operation: After filling the bin with the desired baits and adjusting the application rate, the operator traverses the specified site. Baits are dispersed at even intervals across the soil surface.

Advantages: Baits can be rapidly spread across treated sites. Broadcast applicators are most effective when

applying baits for rodents that forage on the surface, such as mice and voles. They also minimize direct contact with baits by the operator.

Disadvantages: Spreading baits across the soil surface increases the chance for encounters by nontarget species. Most species detrimental to forest resources can be more specifically targeted by placing baits within their burrow systems or on runways. Greater amounts of toxicants may be needed than with other methods because encounters are by chance rather than with strategically placed baits.

Sources:

Davenport Seed Corporation
Herd Seeder Company

Burrow-Builders

Function: Burrow-builders construct artificial burrows and automatically dispense bait underground for pocket gophers.

Description: A tractor-drawn unit is available in hydraulically operated three-point hitch models. The burrow-builder consists of a coulter blade to cut roots of plants ahead of the knife, a knife and torpedo assembly to construct the artificial burrow, a bait bin with a metering device to dispense baits at the desired rate, a dispensing mechanism, and a packer wheel to close the burrow.

Similar machinery can be used to dispense bait for voles. Voles prefer to travel along trails and are unlikely to encounter most bait spread at random. Instead of dispensing bait in burrows, the machine dispenses bait along a path created along the ground surface.

Operation: The tractor is driven across the treated site, constructing burrows and automatically dispensing bait. Artificial burrows should be constructed at depths similar to those for the natural pocket gopher burrows found in the area and spaced at 20- to 25-foot

intervals. Burrows that encircle the perimeter of the treated site will help to inhibit pocket gopher invasions from areas outside the site. However, continuous burrows should not be extended across the treated site as these may be used by pocket gophers for rapid movement across the site.

While building burrows the operator should periodically check to ensure that the bait dispenser is not plugged and that the burrows are in good condition. Wet soil and debris may collect on the packer wheel or knife shank, creating inadequate burrows. Burrows created in extremely dry soil tend to collapse.

Advantages: Burrow-builders or trail-builders can rapidly and economically treat large acreages. Toxicants are delivered beneath the surface or on trails where they are encountered by pocket gophers or voles. This approach increases the likelihood of encounters by pocket gophers or voles, while decreasing the incidence of nontarget encounters.

Disadvantages: Burrow-builders or trail-builders are not applicable when treating small acreage, or treating sites with excessive debris or steep terrain.

Sources:

The Perry Company
RCO, Inc.
Rue R. Elston Company
Western Alfalfa
Wilco Distributors, Inc.

Bait Stations

Function: Bait stations (Figure 32) permit a continuous supply of bait to be available to the target species, while hindering access to nontarget animals.

Description: A variety of bait stations made of plastic, cardboard, or

metal are available through commercial suppliers. They generally consist of a box with an opening suitable for entry by the target species and some kind of bar or lip to prevent the bait from being easily carted out of the container.

Homemade bait stations can be easily created by using old tires, a pipe, or an enclosed box. The bait station should be clearly labeled with "poison" or similar warning, and secured to prevent it from being knocked or dragged out of place. Some rodenticide uses may require tamper-proof bait stations to reduce human or nontarget hazards. Check the pesticide labeling carefully before beginning a program.

Operation: Bait stations need to be placed in the field a week or so prior to treating with baits. Prebaiting with nontoxic foods may be beneficial. Once the target animals become accustomed to the station, bait is placed inside. Bait stations need to be checked frequently to replace ingested or contaminated bait. After the desired effect is achieved, bait stations need to be removed. Any remaining bait should be returned to its original container or disposed of properly.

Advantages: Bait stations are relatively inexpensive and easy to maintain. They minimize environmental hazards and risks to nontarget species and can be safely handled by humans. A continuous

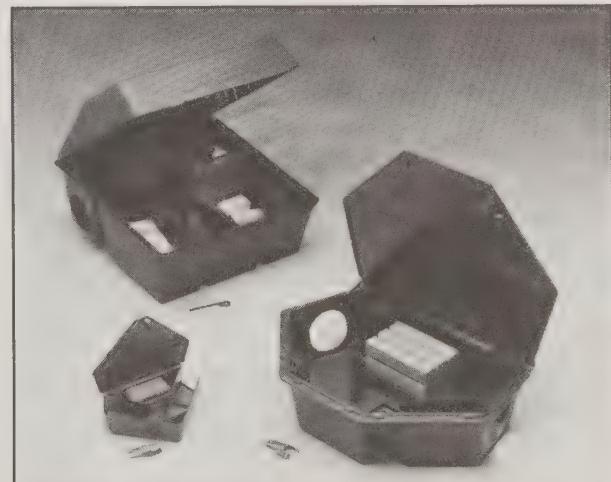


Figure 32—Assorted bait stations for small rodents.

supply of bait can be maintained in good condition; this is particularly important for the use of anticoagulants, or when rapid invasion occurs on treated sites.

Disadvantages: Most species detrimental to forest resources can be more specifically targeted by placing baits within their burrow systems. Prolonged maintenance of bait stations can become expensive as they require more intensive labor than other delivery methods.

Sources:

B&G Chemicals and Equipment Co., Inc.
Bell Laboratories, Inc.
Eco-Bait
Geyer Irrigation
The Huge Company
J. T. Eaton & Company, Inc.
LiphaTech, Inc.
Motomco, Ltd.
Solvit, Inc.
Wilco Distributors, Inc.
Woodstream Corporation

Probes and Bait Dispensers

Function: A probe can be used to locate burrows and create an opening to drop bait. A bait dispenser is a probe

with an automatic bait dispenser attached.

Description: Probes can be made of almost any rounded material that can be used to penetrate the soil. A broom or shovel handle works quite well in soft soil for moderate use. A more durable probe works better when the soil becomes harder or for more extensive efforts. Probes generally look like a large "T" that is about 30 inches long with a handle 12 to 15 inches long across the top. A foot rest may also be attached to aid in penetrating hard surfaces. Bait dispensers are similar, except that a bait container is attached, along with a mechanism that dispenses measured doses of bait when activated.

Operation: The operator probes the soil around mounds where an active pocket gopher system is likely to be encountered. Fresh mounds or plugs are an indication of recent activity. An experienced operator can feel the probe strike a burrow by the reduced resistance as the probe enters the open space.

Once a system is located, the operator can dig out the system and insert bait with a spoon, or drop the bait through the opening created by the probe. A

hollow tube inserted through the probe hole helps to deliver bait to the burrow. The bait dispenser is operated in a similar manner. Once a burrow is located, the delivery mechanism is triggered and the bait is automatically dispensed into the burrow. Regardless of the approach, the entry hole needs to be completely sealed or the pocket gopher may plug the hole and cover the bait with soil while doing so.

Advantages: Probing, and then directly inserting bait, ensures that the bait is delivered into the burrow system. Exposure of baits to nontarget species is minimal with these methods.

Disadvantages: Hand baiting large areas is labor intensive. Skilled operators are necessary so that burrows can be readily located and the bait properly placed. New personnel will require substantial training.

Sources:

Don Sprague Sales, Inc.
Eckroat Seed Company
Fuhrman Diversified, Inc.
Quinn Manufacturing Company
Rue R. Elston, Inc.
Southwest Chemical Company
Topo Manufacturing and Welding Co.
Wilco Distributors, Inc.

Repellents (Chemosensory)

Wildlife damage to forest resources is predominately inflicted by foraging animals. Seedlings and sapwood are an attractive food resource for a variety of wildlife. The extent to which wildlife forage on these resources depends on the availability and relative desirability of alternative foods.

Repellents (Figures 33 and 34) can be applied to seedlings to render them less attractive than the alternative foods. Consequently, animals select for plants or foraging areas other than those protected with repellents. The avoidance of repellents by wildlife may be innate or acquired through a conditioned food aversion.



Figure 33—"Big Game Repellent" used to inhibit foraging by herbivores.

Repellents that elicit initial avoidance are generally either irritants (e.g., capsaicin) or those that evoke a "fear" response (e.g., predator scents). These repellents require no prior conditioning to elicit avoidance behavior. Irritants stimulate trigeminal pain receptors. For example, jalepeño peppers contain capsaicin that activates pain receptors in mammals when ingested. Fear-inducing repellents are usually animal waste products or predator odors. Degrading waste products and most predator urine emit sulfurous odors.



Figure 34—"Tree Guard" repellent.

Conditioned food aversions occur when ingestion of novel foods is paired with nausea. Thus, any flavor paired with gastrointestinal distress can become an effective repellent. Efficacy of repellents based on conditioned aversions, however, are generally limited because animals must first be conditioned to avoid these materials. Further, the stimulus must be novel for the animals to form a strong aversion. Damage inflicted to seedlings during conditioning or subsequent sampling may be extensive. The use of repellents based on conditioned aversions can be especially problematic if the damage is inflicted by a transitory or a migratory species (i.e., deer moving from summer to winter ranges).

Wildlife responses to repellents vary among individuals, as well as among species. Obviously, responses to repellents that require conditioning will reflect each animal's prior experience. Less obvious, however, are response differences that occur because some

species are more responsive to certain stimuli than others. Sensitivity to "irritating" agents varies among species. Agents that stimulate trigeminal pain receptors in some species fail to stimulate similar receptors in other species. For example, mammals tend to avoid capsaicin, while birds are indifferent to it. Conversely, low concentrations of anthranilates are irritating to birds while similar concentrations are not offensive to mammals.

Response differences among wildlife also appear to reflect their foraging strategies. Carnivores (e.g., dogs) and omnivores (e.g., bears) avoid bittering agents, while most herbivores (e.g., deer, pocket gophers) are indifferent to them unless they have been previously paired with nausea. Likewise, meat eaters, such as coyotes and bears, are attracted to sulfurous odors, while most herbivores usually avoid substances with these odors.

A repellent's efficacy also depends on the desirability of the protected plant as a food source. Alternative forages are more likely to be selected if the protected plant is not a valued food source. Preferred plants (e.g., western red cedar) are more difficult to protect than plants that are not preferred (e.g., foxglove).

An effective program to reduce wildlife foraging using repellents also depends on the availability of alternative forage. An abundance of alternative forage permits animals to readily direct their destructive behavior toward other plants. After treatment, an animal's foraging choices will depend on the size of the protected area relative to its territorial boundaries. Species with vague or extensive territories, such as deer or bear, can more easily move to new areas to locate alternative forages than can species (e.g., pocket gophers) with small and more rigid territorial boundaries.

Foraging pressure on protected plants also depends on the types and densities of wildlife species. Competition among and within species may cause animals to select less preferred foods. Likewise, high population densities may limit foraging alternatives, rendering repellents less effective.

Some repellents, if improperly applied, can pose a human or environmental hazard. Therefore, caution must be exercised in the handling, storing, applying, and disposing of repellent materials. The applicator assumes responsibility for ensuring that all legal and safety precautions are followed. Restrictions and safety precautions provided on product labels must be carefully read and followed. Federal and State registrations certify that it is legal to use the product according to the conditions and restrictions stipulated on the approved label. Registration does not guarantee the availability or the efficacy of a product.

Generally, chemosensory repellents are categorized as those that deter animals from an area or reduce direct contact with a plant.

Area Repellents

Function: Area repellents inhibit wildlife presence near the vulnerable forest resource.

Description: Area repellents emit odors that are undesirable to the target species. Degrading animal waste products and predator odors produce sulfurous odors that are generally offensive to most herbivores. A number of commercially available repellents incorporate these and other products into area repellents. Homemade remedies, such as bags filled with human hair or soap bars, have also been reported to reduce damage inflicted by foraging wildlife.

Operation: Place area repellents within the area to be protected following instructions on the product's label. The distance between repellent materials, and the amounts applied at each spot will depend on the product. Efficacy claims may report it to cover an extensive area or protect only within the immediate vicinity of the application. After the repellent is dispersed, monitor animal activity to determine whether it is working.

Several options need to be considered if the program is not effective. Additional material may be required if the original application was inadequate or weather conditions are inhibiting performance. Rain may dilute the repellent. Odors may be less volatile during cold temperatures. An alternative type of repellent may be more effective. Repellent products are not equally effective at deterring all species. Periodic switching of repellent types may decrease animal habituation. It may also be necessary to supplement or replace the repellent program with another approach to reduce damage.

Advantages: Area repellents protect all plants and plant parts within a treated area and are generally not harmful to wildlife or humans. Some area repellents can be an inexpensive means to protect forest resources and require little equipment or few hours of work to apply.

Disadvantages: Depending on the type of repellent and the number of applications, this approach can become expensive and labor intensive. Animals habituate to most repellents fairly quickly. Effective area repellents can potentially exclude wildlife from favorable habitat and other forage resources.

Sources:

Avitrol Corporation
Boehringer Ingelheim Animal Health, Inc.
Bonide Products, Inc.
Bushwacker Backpack and Supply
Champon 100% Natural Products, Inc.
Coughlan Products Corporation
Degesh America, Inc.
Dragon Corporation
Dr. T's Nature Products Company, Inc.
Faesy and Besthoff, Inc.
Farnam Companies, Inc.
Gustafson, Inc.
HACO, Inc.
IntAgra, Inc.
Integral Designs
J.T. Eaton & Company, Inc.
Lakeshore Enterprises
Margo Supplies, Ltd.
Miller Chemical & Fertilizer Corporation
Nature's All Natural Products, Inc.
Nortech Forest Products, Inc.
Pace International, Ltd.
Plant Pro-Tech, Inc.
PMC Specialties Group, Inc.

Contact Repellents

Function: Contact repellents render plants less desirable for consumption by animals.

Description: Contact repellents are placed on or absorbed by the protected resource, and are generally avoided because of an aversive taste or smell. Animals enter areas treated with effective contact repellents, but do not ingest the treated plants. Most contact repellents are applied directly to the plant. Systemic repellents, however, are applied to the soil and absorbed by the plant. Many commercially available area repellents also work as contact repellents.

Operation: First, check to ensure that the repellent is not toxic to the plant. Treat and observe a few plants if phytotoxicity data are not provided on the label.

Repellents must be applied according to the restrictions and directions provided on the label. For the best results, treat each individual seedling. On large areas, however, it may be possible to treat only those seedlings located along the outside edge (100 feet) of the plot. Treating only the exterior seedlings reduces labor and material costs and may work if animals do not normally cross the untreated portion. Observe areas to determine whether wildlife are avoiding treated plants.

Ineffective efforts to reduce damage with repellents generally occur because an ineffective repellent was applied, or because the delay between treatments was too great. Few, if any, of the repellents currently available remain

active for more than 3 or 4 months. Weather conditions, particularly precipitation, may further decrease the period during which plants are protected by repellents.

Advantages: Contact repellents are generally not harmful to wildlife or to humans. These repellents protect specific plants and do not hinder wildlife use of other forage or habitat.

Disadvantages: Depending on the cost of the repellents and the need for repeated applications, this approach can be expensive and labor extensive. Animals tend to habituate to most repellents fairly quickly. Some repellents may be hazardous to humans if not handled carefully, or detrimental to the environment if not applied correctly. Extreme weather conditions may dilute contact repellents and make them ineffective.

Sources:

Animal Repellents, Inc.
Boehringer Ingelheim Animal Health, Inc.
Bonide Products, Inc.
Burlington Scientific Corporation
Bushwacker Backpack and Supply
Champon 100% Natural Products, Inc.
Coughlan Products Corporation
Degesh America, Inc.
Dr. T's Nature Products Company, Inc.
Earl May Seed & Nursery Company
Gustafson, Inc.
HACO, Inc.
IntAgra, Inc.
Integral Designs
J.C. Ehrlich Chemical Company
Lakeshore Enterprises
Margo Supplies, Ltd.
Miller Chemical and Fertilizer Corp.
Nature's All Natural Products, Inc.
Nortech Forest Products, Inc.
Nott Manufacturing Company, Inc.
Pace International, Ltd.
PMC Specialties Group, Inc.
Sudbury Laboratories, Inc.
Wilbur-Ellis Company

Frightening Devices

Visual displays or noises that serve to alarm or appear threatening can be installed to frighten wildlife away from forest resources. Yelling at wildlife ingesting agricultural products was probably the first historical effort to prevent animal damage. Modern noisemakers are still used to scare animals away from resources. Visual displays, such as scarecrows, are also traditional means to alleviate depredation in gardens or grain fields. Modern displays are generally either more realistic in appearance or less cumbersome and easier to install than the traditional scarecrow. Frightening devices are most commonly used to deter birds, but they may also be used to deter mammals.

Animals are generally wary of any unfamiliar sound or sight, but they become less wary with time unless the noise or vision is paired with a negative reinforcer. Familiarity of wildlife to frightening devices can be minimized by installing or operating the devices only during periods when resources are most susceptible to damage. Devices, however, need to be used immediately after the onset of damage. Established movements and behaviors are much more difficult to disrupt than are newly forming behavioral patterns.

Efficacy of products can usually be increased by alternating techniques or use patterns. Sporadic displays or devices that are activated by an animal's presence are more effective than permanent or routine displays. Visual displays combined with noisemakers are generally more effective than either technique implemented alone. For example, sirens and strobe lights activated at irregular intervals are more effective than either a constant visual display or loud noises generated at fixed intervals. Supplementing these techniques with occasional lethal measures (e.g., shooting) further enhances their continued efficacy. Properly trained dogs confined within the boundaries of the protected resource are very effective at frightening wildlife.

Visual Devices

Reflectors

Function: Reflectors are used to frighten wildlife away from resources by reflecting flashes of natural or artificial light.

Description: Reflectors are passive devices that can be used alone or in conjunction with artificial lights to frighten wildlife species away from protected areas. Mylar reflecting tape can be attached to stakes or suspended from wire strung between stakes placed within and around the protected area. The mylar tape is designed to reflect sunlight. Movement by the wind causes sporadic flashes and noise. Wrinkled aluminum foil also works well as an effective reflector, producing sporadic flashes of light and erratic noises when blown by the wind.

Reflectors fitted within molded mounts attached to stakes are more permanent and come ready to install. These types of reflectors are most beneficial to increase the area of coverage or efficacy of artificial light systems operated at night.

Operation: Mounted reflectors can be inserted directly into the ground. Otherwise, install posts or hang reflectors from vegetation or debris in the area. Concentrate reflectors on areas where the target species is most active. Reflectors should not be set in shaded areas. When reflectors are set to complement artificial light, ensure that a clear path exists between the light source and the reflector. Occasionally alter reflector locations to reduce habituation.

Advantages: Reflectors are relatively inexpensive and easy to install, requiring a minimal amount of maintenance. They are not hazardous to wildlife or humans.

Disadvantages: Ineffective at night or on cloudy days, unless combined with artificial light. Most animals habituate to reflectors.

Sources:

C. Frensch, Ltd.
Orchard Supply Company
Strieter Corporation
Ted Dodge Service
Trucall

Artificial Light

Function: Light can be used to illuminate areas or to produce flashes to frighten animals away from protected areas. Nocturnal species avoid well-lit areas, while other species may restrict their use of these sites. Light flashes are used to scare animals away from specific areas.

Description: Light sources vary from simple to complex. All, however, require a lamp, power source, and protective cover. Several lamps can be operated by a common power source. Long-term efficacy of sporadic lights can be enhanced by adding several optional devices, such as strobes, timers, revolving platforms, or trip-switches.

Operation: Continuous lights mounted on poles need to be strategically placed so the entire area is well lit. Sporadic lights need to be set so they are clearly visible by intruding animals, preferably so the flash will illuminate the animal. Changing locations and schedule of periodic flashes helps to reduce habituation. Artificial lights need to be checked frequently to ensure that the light and optional mechanisms are functioning properly.

Advantages: Lights are active systems and do not depend on natural elements (e.g., sunlight, wind) to operate. Lights are not hazardous to wildlife or humans. Nocturnal species do not habituate to continuous light. Further, animals are less likely to habituate to actively changing systems than to passive, constant systems.

Disadvantages: Lights can be expensive and require more effort to install and maintain than passive systems. Lights can be distracting and

bothersome to neighbors. As animals habituate to light systems, lights become less effective.

Sources:

Bird-X, Inc.
The Huge Company, Inc.
Tripp-Lite Manufacturing Company

Effigies

Function: Human or predator effigies are installed to create the illusion of an unsafe environment.

Description: Effigies create the illusion that natural predators or humans are active in the protected area. Predominately used to deter birds, effigies are also installed to frighten big game. Scarecrows (e.g., human effigies) can be anything from shirts stuffed with straw and fastened to poles to lifelike mechanized models. Bright colors, or reflectors and streamers that flutter in the wind, increase the efficacy. Predator effigies also encompass the continuum from simple silhouettes to lifelike models. The more realistic models, and effigies that incorporate some movement, are the most effective. Human effigies paired with occasional shooting can be very effective.

Operation: Select effigies that are likely to produce an alarming or threatening situation. For example, raptor models may induce avoidance by small birds but go unheeded by elk. Place effigies where they are clearly visible to the target species. Change locations periodically to reduce habituation.

Advantages: Simple models are inexpensive and easy to install. Effigies are not dangerous to wildlife or humans.

Disadvantages: Complex models can be relatively expensive and may require some maintenance. Efficacy of effigies declines as animals habituate to them

unless the devices are paired with other negative consequences.

Sources:

Bird-X, Inc.
Flambeau Products Corporation
FLR, Inc.
The Huge Company, Inc.
Orchard Supply Company
Sutton Ag Enterprises, Inc.

Balloons, Kites, and Flags

Function: Balloons, kites, and flags are used to scare wildlife away from an area by creating an unfamiliar situation.

Description: Balloons (Figure 35) come in a variety of colors and sizes. Several models are painted with bright colors and large circular patterns to resemble the eyes and open mouth of predators. Balloons are either suspended from poles or filled with helium and tethered to stakes.

Kites are hung from wires or strings strung across the site, or flown over the site by an operator. Kites designed to frighten birds may double as predator effigies. A predator design, combined with the fluttering and dipping motions of a kite, can be realistic and effective.

The flapping motions and noises created by flags can also restrict animal use of an area. Flags can be purchased, or constructed by attaching sheets of plastic or cloth to a stake. Fabrics with distinct and clearly visible colors should be used to create flags.

Operation: Balloons, kites, and flags have to be clearly visible to be effective. The recommended number of balloons and flags depends on the situation, though as few as one per acre may be adequate. Switching colors and locations of balloons and flags can prolong the effective life of these devices. A skilled operator can effectively cover a substantial area with a single kite.

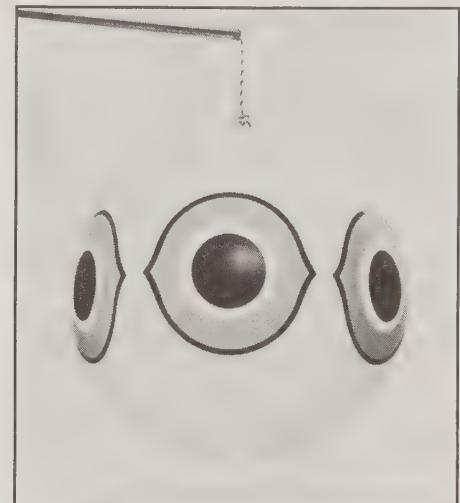


Figure 35—"Scare-Eye" balloon.

Advantages: Initial costs of balloons, kites, and flags are relatively inexpensive. These devices are easy to install and require minimum amounts of maintenance. None of these devices are detrimental to wildlife or the environment.

Disadvantages: Operator-flown kites can become labor intensive. Helium-filled balloons need to be maintained on a regular basis. The efficacy of these devices declines as animals habituate to them over time.

Sources:

Atmospheric Instrumentation Research, Inc.
Birdbusters
Bird Scare Predator Eye, Inc.
Bird-X, Inc.
C. Frensch, Ltd.
Cochrane's of Oxford, Ltd.
Ecopic
Hartman's Plantation, Inc.
Margo Supplies, Ltd.
Nixalite of America, Inc.
Orchard Supply Company
Reed-Joseph International Company
Rid-A-Bird, Inc.
Sutton Ag Enterprises, Inc.
Wildlife Control Technology, Inc.

Noisemakers

Distress Calls, Sirens, and Horns

Function: Distress calls mimic the sounds of birds in trouble, which frightens and discourages birds from landing in an area. Sirens, horns, and other sounds can also be used to scare birds and mammals from an area.

Description: Distress calls are commonly generated by battery-operated portable cassette recorders. Recorders are connected to an amplifier and a long-range speaker. Recordings of distress calls from a variety of birds are commercially available. Predator calls, barking dogs, or human noises can also be recorded and played over the same system to scare problem species.

A variety of compressed air or battery-operated sirens and horns are commercially available (Figure 36). Like the cassette recorders, these are attached to a directional speaker that focuses the noise toward the problem area.

Operation: Place the cassette player with the directional speaker pointed toward the major problem area. Turn the volume to a level loud enough for birds to hear the distress calls over other noises. Initiate calls at times when the birds normally gather to feed; continue the distress calls until depredation ceases. Sounds to scare other animals can be generated in a similar fashion. Habituation to the sounds can be delayed if the machine is not operated continuously and tapes are switched periodically. A trip device or timer set to operate the player sporadically will further reduce the rate of habituation.

Sirens and horns are operated similarly to distress calls. Strategically place the siren or horn where it will be directed at the most severe depredation sites. A timer or trip device attached to the siren

or horn will enhance the efficacy of the operation. Hand-held sirens and horns can also be used by an operator to scare animals away from a site.

Advantages: Portable cassette players can easily be installed or moved to new locations. After a moderate initial expenditure, the operating expenses are minimal. Distress calls or other vocalizations are not harmful to wildlife.

Disadvantages: Animals generally habituate to sounds that are not reinforced with punishment. Hand-operated devices can become labor intensive. Loud noises are often distracting to neighbors. Electronic or battery-operated devices placed in the field require weatherproofing and frequent maintenance.

Sources:

Birdbusters
Bird-X, Inc.
C. Frensch, Ltd.
Denver Wildlife Research Center
Falcon Safety Products, Inc.
Farm and Industrial Supplies Company
Johnny Stewart
Margo Supplies, Ltd.
P.S. Olt Company
Reed-Joseph International Company

Signal Broadcasting Products, Inc.
Tomko Enterprises, Inc.
Weitech, Inc.

Ultrasonic Devices

Function: Ultrasonic devices (Figure 37) emit high frequency sounds to discourage wildlife from entering an area.

Description: Ultrasonic frequencies exceed 20,000 hertz, a level that is not audible or disturbing to humans. Several models of ultrasonic devices are commercially available. Devices generally consist of an ultrasonic unit and a battery or solar power source. Some devices are equipped with mounting brackets; others are affixed to poles. Optional motion detectors are available that activate the device for a specified time interval whenever it is approached by an animal.

Operation: Install the ultrasonic devices such that they cover or at least encircle the problem area. Spacing will depend on the particular device; most are reported effective up to at least 30 feet. Timers or trip devices will prolong the power supply.



Figure 36—"Bird Gard ABC" noisemaker system used to frighten animals.



Figure 37—"Usonic Sentry" ultrasonic device used to frighten animals.

Advantages: Ultrasonic devices are relatively inexpensive to operate. Animals do not habituate to ultrasonic frequencies as readily as they do to audible sounds. Humans are not distracted by ultrasonic frequencies and the devices are not detrimental to the environment or harmful to animals.

Disadvantages: The original expenditure for ultrasonic devices to cover a large area can be expensive. Ultrasonic frequencies diminish rapidly with increasing distance from the source. Further, shadows of ultrasonic frequencies are formed wherever sound waves are obstructed. Areas with debris or substantial amounts of vegetation will need to be cleared or additional devices installed. Even though ultrasonic frequencies are inaudible, high decibel levels may damage human hearing; appropriate hearing protection should be provided to operators.

Sources:
Adams Dominion, Inc.
Bird-X, Inc.
C. Frensch, Ltd.
Falcon Safety Products, Inc.
Farm and Industrial Supply Company

Johnny Stewart
Margo Supplies, Ltd.
Medline of Colorado
Orchard Equipment and Supply
Reed Joseph International Company
Signal Broadcast Products, Inc.
Weitech, Inc.

Automatic Exploders

Function: Automatic gas exploders (Figure 38) emit loud explosive noises to frighten animals away from an area.

Description: Automatic gas exploders operate on propane or acetylene. The exploder operates by igniting gas collected within a chamber. A cannon or tube directs and amplifies the explosive noise. An adjoining storage tank supplies gas to the exploder. Most tanks contain adequate fuel for 12,000 or more explosions. The exploder is often mounted on a tripod to elevate it above surrounding vegetation. Exploders come with various options including timers, rotating directional mechanisms, automatic erratic volume control, dual and triple cannons, and attachable visual displays.

Operation: Spread exploders across the problem area. The necessary number of exploders depends on your objectives and site-specific factors; however, operational estimates for the coverage of one exploder range from 3 to 40 acres. Field observations will indicate how many and where the exploders need to be established. Elevate or set exploders so that the

sound will not be muffled by surrounding vegetation or debris. Habituation will be less rapid if exploders are fired in irregular directions, and with varying time intervals and magnitudes. For best results, move the exploders to new locations every other day.

Advantages: Automatic cannons work in the absence of an operator and require only moderate maintenance. The exploders are not harmful to wildlife.

Disadvantages: Animals habituate to the noise after varying periods of time. Labor to move exploders repeatedly can become expensive if a large number of exploders are necessary to cover an extensive area. The noise may be a problem for neighbors.



Figure 38—Assorted "Zon Scarecrow Guns" used to frighten animals.

Sources:

Agricultural Supply, Inc.
C. Frensch, Ltd.
Field Systems Corporation
Harmon International, Inc.
H.C. Shaw Company
Margo Supplies, Ltd.
M.J. Flynn, Inc.
Orchard Equipment and Supply Co.
Pisces Industries
Reed-Joseph International Company
Sutton Ag Enterprises, Inc.
Teiso Kasei Company
Wildlife Control Technology, Inc.

Pyrotechnic Devices

Function: Hand-fired noise devices projected by an operator over an area to frighten animals.

Description: Pyrotechnic devices (Figure 39) are fired from a hand-held gun by an operator. Various types are available, but most fall within the general categories of bangers, screamers and shell crackers. Bangers can be projected from 75 to 125 feet and explode with a loud bang or pop. Screamers make a loud screeching or whistling noise as they travel 300 to 350 feet across a protected site. At night, screamers produce a visual effect similar to a twirling bottle rocket. Banger and screamer cartridges are projected by .22-caliber blanks fired from hand-held revolvers. Shell crackers, the loudest of the pyrotechnic devices, explode with a bang. Fired from an open choke 12-gauge shotgun, the shell cracker will travel about 200 feet.

Operation: An operator makes regular visits to a depredation site, firing pyrotechnics across the site whenever the offending species is present. Devices should be projected such that they

explode over the site and not so that they hit animals or explode on the ground. Direct hazing should follow pyrotechnics whenever animals fail to respond to the noise. Possession and use of pyrotechnics may require a permit from the fire marshal. Check the launch barrel after each discharge because wads may stick in the barrel.

Advantages: Animals are less likely to habituate to pyrotechnics because they are delivered at specific times and directed toward specific places by an operator. Animals that fail to heed pyrotechnic devices can be immediately hazed. Noise produced by pyrotechnic devices is less offensive to neighbors because devices are fired only when necessary. Devices are relatively safe for both wildlife and humans.

Disadvantages: Pyrotechnics require the presence of an experienced operator to monitor sites and to fire them.

Pyrotechnics can cause fires and are hazardous to the operator if not handled with care.

Sources:

Agricultural Supply, Inc.
C. Frensch, Ltd.
Margo Supplies, Ltd.
Marshall Hyde, Inc.
New Jersey Fireworks Company
Reed-Joseph International Company
Stoneco, Inc.
Sutton Ag Enterprises, Inc.
Wald & Company
Western Fireworks Company
Wildlife Control Technology, Inc.



Figure 39—Pyrotechnic devices used to frighten animals.

Alternative Forage

Wildlife damage to forest resources is invariably induced by foraging animals. Wildlife feed on seedlings and the sapwood of larger trees to obtain a source of nourishment. Dietary selection, however, is relative and depends on the available options. Providing wildlife with viable alternative foraging options can alleviate the extent of foraging pressure directed toward forest resources.

Several approaches can be used to provide wildlife with alternative foods. Desirable foods can be distributed across problem areas or on adjacent sites to encourage animals away from the protected resources. For example, alfalfa distributed along migratory trails may reduce the tendency of ungulates to browse seedlings. Another approach is to plant or encourage the establishment of natural forages that are preferred by wildlife. Some plants, such as cat's ear, are ingested by most herbivorous rodents, as well as ungulates. Animals can also be provided food supplements in semipermanent structures strategically placed adjacent to or within sites that are being damaged or that are vulnerable to damage.

Before implementing a feeding program to reduce forest damage, the long-term consequences need to be considered. Alternative forages can increase or prolong the presence of wildlife on selected sites. Increased resources may encourage additional animals to frequent the area, or an improved nutritional status may enhance reproductive success. Further, resource-dependent territorial boundaries of rodents may shrink with improved forage resources, which in turn permits more individuals to exist within a given forest unit. Big-game herds may suspend or delay migratory movements to utilize available forages. A feeding program, therefore, might actually increase wildlife pressure on forest resources if the program is not sustained, or fails to meet the increasing demands.

A successful program needs to be specific in targeting a problem for a known time interval. In addition, a means to continue the program indefinitely or a means to wean the supplemented animal from the program should be identified. The potential for animals to revert to protected forest resources also needs to be anticipated and avoided.

The supplemental bear feeding program coordinated by the Washington Forest Protection Association is an example of an effective feeding program to prevent forest damage. The program provides a favorable alternative to bears. They are offered a choice of ingesting nutritious pellets rather than girdling trees when other natural foods are limited. A natural weaning from the program occurs as bears revert to natural forages (e.g., berries) as they become available.

fall through a narrow gap beneath the metal sheet. This self-feeding mechanism permits a continuous supply of pellets, but prohibits bears from spilling or playing with the food. A heavy roof insulated with foam keeps the pellets dry and limits bears to feeding from the front entrance.

The supplemental pellets are produced under the direction of the Washington Forest Protection Association. Sugars are considered the most important ingredients to alleviate damage to trees. Pellets also contain fats, proteins, vitamins, and minerals to provide a balanced diet for bears. A low moisture content (less than 10%) enhances bear acceptance and increases the viable shelf life of pellets. Individual pellets resemble a greenish-colored dry dog food and are 0.25 inches in diameter and about 0.5 inches long.

Supplemental Bear Feeding Program

Function: Bears are provided a supplemental food to reduce their destructive foraging on trees during the spring.

Description: Self-feeders are constructed from 55-gallon drums (Figure 40). Bears can obtain pellets from an opening cut in the lower front portion of the barrel. The feeding plate is separated from the storage compartment by a metal sheet inserted diagonally within the barrel. Pellets taken from the feeding plate are automatically replaced as pellets



Figure 40—Bear feeding station used to supply bears with supplemental pellets during the spring.

Bear feeders are securely fastened to trees approximately 10 inches off the ground to avoid water and rodent problems. Bait (e.g., a beaver carcass) may be used to initially attract bears to stations, but is not necessary once bears begin feeding. Each station holds approximately 200 pounds of pellets. Active stations need to be restocked once a week. Wet or powdery feed is

removed before a station is restocked with new pellets. At the end of the damage season all feeding stations are removed from the forests.

Advantages: Supplemental feeding of bears is not detrimental to bears or other wildlife species and is usually well received by the general public.

Disadvantages: The program is expensive and labor intensive to implement and maintain. The long-term impacts of supplemental feeding on subsequent bear behavior, reproductive success, and tree damage are not well understood.

Source:
Washington Forest Protection Assoc.

Sources

Adams Dominion, Inc.
P.O. Box 690
Prospect, KY 40059
Phone: (502) 228-3361

ADPI Enterprises, Inc.
3621 B Street
Philadelphia, PA 19134
Phone: 800-621-0275
Phone: (215) 425-8866
Fax: (215) 739-8480

Agricultural Supply, Inc.
1435 Simpson Way
Escondido, CA 92029
Phone: 800-527-6699
Fax: (619) 741-9412

American Feed & Farm
3310 H Street
Omaha, NE 68107
Phone: 800-642-9904

American Forestry Technology, Inc.
100 North 500 West
West Lafayette, IN 47906
Phone: (317) 583-3311
Fax: (317) 583-3318

Animal Care Equipment & Services
P.O. Box 3275, 613 Lee Bert Way
Crestline, CA 92325
Phone: 800-338-2237
Phone: (909) 338-1791
Fax: (909) 338-2799

Animal Management, Inc.
720 Eppley Road
Mechanicsburg, PA 17055-9786
Phone: 800-745-8173
Phone: (717) 790-9347
Fax: 800-745-8193

Animal Repellents, Inc.
P.O. Box 510
Orchard Hill, GA 30266
Phone: 800-241-5064
Phone: (404) 227-8222

APGAR, INC., Inc.
Mill River Supply
375 Adams
Bedford Hills, NY 10507
Phone: (914) 666-5774
Fax: (914) 666-9183

Archem Corporation
1514 11th Street
Portsmouth, OH 45662
Phone: 800-635-1125
Fax (614) 353-1124

Atmospheric Instrumentation
Research (Air), Inc.
8401 Baseline Road
Boulder, CO 80303
Phone: (303) 443-7187
Fax: (303) 499-1767

Avitrol Corporation
7644 East 46th Street
Tulsa, OK 74145
Phone: 800-633-5069
Phone: (918) 622-7763
Fax: (918) 622-2527

Baygard-Bay Mills, Ltd.
6 Holtby Avenue
Brampton, Ontario
Canada L6X 2M1
Phone: (905) 456-3394
Fax: (905) 456-1452

Bell Laboratories, Inc.
3699 Kinsman Boulevard
Madison, WI 53704
Phone: (608) 241-0202
Fax: (608) 241-9631

Bernardo Chemical, Ltd., Inc.
P.O. Box 9040
Rock Mount, NC 27804-7040
Phone: (919) 443-9325
Fax: (919) 443-5386

B&G Chemicals & Equipment Co., Inc.
10539 Maybank
Dallas, TX 75354-0428
Phone: 800-345-9387
Phone: (214) 357-5741
Fax: (214) 357-4514

Bigelow Trap Company
979 Milford Avenue
Marysville, OH 43040
Phone: (513) 642-6786

Birdbusters
1083 Thomas Jefferson Street NW
Washington, DC 20007
Phone: 800-662-4737
Phone: (202) 338-6263
Fax: (202) 338-6268

Bird Scare Predator Eye, Inc.
132 East Demont Avenue, #122
Little Canada, MN 55117-1561
Phone: 800-252-0933
Phone: (612) 482-1123
Fax: (612) 482-1241

Bird-X, Inc.
730 West Lake Street
Chicago, IL 60661
Phone: 800-662-5021
Phone: (312) 648-2191
Fax: (312) 648-0319

B-Kind Animal Control Equipment
Southeastern Metal Products, Inc.
1200 Foster Street NW, P.O. Box 93038
Atlanta, GA 30377
Phone: (404) 351-6686

Blue Mountain Industries
20 Blue Mountain Road, P.O. Box 4000
Blue Mountain, AL 36204
Phone: (205) 237-9461
Fax: (205) 237-8816

B.N. Bolton, Inc.
Route 1, Site 11, Comp. 42
Vernon, British Columbia
Canada V1T 6L4

Boehringer Ingelheim Animal Health, Inc.
Anchor Division
2621 North Belt Highway
St. Joseph, MO 64506-2002
Phone: (816) 233-1385

Bonide Products, Inc.
2 Wurz Avenue
Yorkville, NY 13495
Phone: (315) 736-3231
Fax: (315) 736-7582

Brookside Industries, Inc.
Route 1, P.O. Box 158
Tunbridge, VT 05077
Phone: (802) 889-3737

Burlington Scientific Corporation
222 Sherwood Avenue
Farmingdale, NY 11735
Phone: (516) 694-9000
Fax: (516) 694-9177

Bushwacker Backpack & Supply Co., Inc.
P.O. Box 4721
Missoula, MT 59806
Phone: 800-695-3394
Phone: (406) 728-6241
Fax: (406) 728-8800

C. Frensch, Ltd.
168 Main Street, P.O. Box 67
Grimsby, Ontario
Canada L3M 4G1
Phone: (905) 945-3827
Fax: (905) 945-4128

Champon 100% Natural Products, Inc.
10528 Mendocino Lane
Boca Raton, FL 33428
Phone: (407) 852-4143
Fax: (407) 852-4143

The Chas. H. Lilly Company
P.O. Box 83179
Portland, OR 97283-0179
Phone: (503) 289-5937
Fax: (503) 289-9216

C.J. Martin Company P.O. Box 630009, 600 West Main Street Nacogdoches, TX 75963 Phone: (409) 560-8282 Fax: (409) 560-8331	Denver Wildlife Research Center USDA-APHIS, Animal Damage Control P.O. Box 25266, Building 16 Denver Federal Center Denver, CO 80225-0266 Phone: (303) 236-7820	Ecopic 725 S. Adams Road, Suite 270 Birmingham, MI 48009 Phone: (810) 647-0505 Fax: (810) 647-7811
Cochrane's of Oxford, Ltd. Leafield Witney England, UK OX8 5NY Phone: 099387-641	Design Packaging 2851 North Sunnyside, #106 Fresno, CA 93727 Phone: (209) 292-9363 Fax: (209) 298-9194	E.I. Dupont DeNemours & Company, Inc. Polymer Products Department Wilmington, DE 19898 Phone: (302) 774-1000 Fax: (302) 774-7321
Conwed Plastics 2810 Weeks Avenue SE Minneapolis, MN 55414 Phone: 800-426-6933 Phone: (612) 623-1700 Fax: (612) 623-2500	Don Sprague Sales, Inc. 1470 Aztec Woodburn, OR 97071 Phone: 800-423-0158 Phone: (506) 981-0297	Faesy & Besthoff, Inc. 143 River Road, P.O. Box 29 Edgewater, NJ 07020 Phone: (201) 945-6200 Fax: (201) 945-6145
"Coon Getter" Cage Traps & Animal Lures Rural Route 4, P.O. Box 109 Miller, SD 57362 Phone: (605) 853-2545	Douglas Products & Packaging Company 1500 East Old 210 Highway Liberty, MO 64068 Phone: 800-223-3684 Fax: (816) 781-1043	Falcon Safety Products, Inc. 25 Chubb Way, P.O. Box 1299 Somerville, NJ 08876-1299 Phone: (908) 707-4900 Fax: (908) 707-8855
Coughlan Products Corporation P.O. Box 1888 Paterson, NJ 07509 Phone: (201) 742-6468 Fax: (201) 742-0359	Dragon Corporation P.O. Box 7311 Roanoke, VA 24019 Phone: 800-533-2488 Phone: (703) 362-3657 Fax: (703) 362-9171	Farm and Industrial Supply Company P.O. Box 31510 Stockton, CA 95213 Phone: 800-221-2884
Critter Control Wildlife Mgmt. Supplies 640 Starkweather Plymouth, MI 48170 Phone: 800-451-6544 Phone: (313) 453-6300	Dr. T's Nature Products Company, Inc. P.O. Box 682, U.S. 19 North Pelham, GA 31779 Phone: 800-299-6288 Phone: (912) 294-9742	Farnam Company, Inc. Sudbury Consumer Products Division P.O. Box 34820 Phoenix, AZ 85067-4820 Phone: 800-825-2555 Phone: (602) 285-1660 Fax: (602) 285-1803
Critter Gitters 4317 Nancy Creek Road P.O. Box 462 Kettle Falls, WA 99141 Phone: (509) 738-2230	Duke Company 508 Brame Avenue, P.O. Box 555 West Point, MS 39773 Phone: (601) 494-6767 Fax: (601) 494-5360	F.B.N. Plastics 225 North L Street Tutare, CA 93274 Phone: (209) 688-7269
Dairyland Power Fence Company North 3985 Hidden Valley Road Hatley, WI 54440 Phone: (715) 446-2297	Earl May Seed & Nursery Company 208 North Elm Street P.O. Box 500 Shenandoah, IA 51603 Phone: (712) 246-1020	Ferrell and Company P.O. Box 92 Union, MS 39365 Phone: 800-848-0759 Phone: (601) 774-8983
Davenport Seed Corporation P.O. Box 187 Davenport, WA 99122 Phone: 800-828-8873 Phone: (509) 725-7015	Eckroat Seed Company 1106 M.L. King Avenue P.O. Box 17610 Oklahoma City, OK 73136 Phone: 800-331-7333 Phone: (405) 427-2489	Ferrett Laboratories, Inc. P.O. Box 437 Sliger, WA 53086 Phone: (414) 644-5252
Davlyn Manufacturing Company, Inc. P.O. Box 49 Spring City, PA 19475 Phone: (215) 948-5050 Fax: (215) 948-5454	Eco-Bait Donald D. Hicks P.O. Box 321 Geraldine, MT 59446 Phone: (406) 737-4291	Field Systems Corporation P.O. Box 1374 Huron, SD 57350 Phone: (605) 352-7703
Degesh America, Inc. P.O. Box 116 275 Triangle Drive Weyers Cave, VA 24486 Phone: (703) 234-9281 Fax: (703) 234-8225	Flambeau Products Corporation 15981 Balplast Road Middlefield, OH 44062 Phone: (216) 632-1631 Fax: (216) 632-1581	

FLR, Inc. P.O. Box 108 Midnight, MS 39115 Phone: (601) 247-4409	Grawes Animal Lures P.O. Box 306 Wahpeton, ND 58074-0306 Phone: (218) 643-3292	H.C. Shaw Company 4554 Quantas Lane, Suite 1 Stockton, CA 95206 Phone: 800-221-2884 Phone: (209) 983-8484 Fax: (209) 983-8449
Forest Protection Products P.O. Box 1047 Coos Bay, OR 97420 Phone: 800-289-7659 Phone: (503) 267-2622 Fax: (503) 269-7300	Green Valley Blueberry Farm 9345 Ross Station Road Sebastopol, CA 95472 Phone: 800-827-9590 Phone: (707) 887-7496 Fax: (707) 887-7499	Herd Seeder Company P.O. Box 448 Logansport, IN 46947 Phone: (209) 753-6311 Fax: (209) 722-4106
Forestry Suppliers, Inc. 205 West Rankin Street, P.O. Box 8397 Jackson, MS 39284-8397 Phone: 800-647-5368 Fax: (601) 355-5126	Gremar Company 4719 Cody Drive P.O. Box 65003 West Des Moines, IA 50265 Phone: (515) 263-3007 Fax: (515) 221-9243	Hoffman Trapping Supplies, Ltd. P.O. Box 805 Russell, Manitoba Canada ROJ 1WO Phone: (204) 773-2270
Fort Dodge Chemical Company P.O. Box 2021 Lompoc, CA 93438 Phone: (805) 736-0065	Guardian Trap Company P.O. Box 1935 San Leandro, CA 94577 Phone: (415) 357-0900	The Huge Company, Inc. 7625 Page Boulevard St. Louis, MO 63130 Phone: 800-873-4843 Phone: (314) 725-2555
Fuhrman Diversified, Inc. 2912 Bayport Boulevard Seabrook, TX 77586-1501 Phone: (713) 474-1388 Fax: (713) 474-1390	Gustafson, Inc. P.O. Box 660065 Dallas, TX 75266-0065 Phone: 800-527-4781 Phone: (214) 985-8877 Fax: (214) 985-1696	IntAgra, Inc. 8500 Pillsbury Avenue South Minneapolis, MN 55420-2219 Phone: 800-468-2472 Phone: (612) 881-5535 Fax: (612) 881-7002
Gallagher Power Fence, Inc. P.O. Box 708900 San Antonio, TX 78270-8900 Phone: 800-553-1680 Phone: (512) 494-5211 Fax: (507) 864-7054	HACO, Inc. 537 Atlas Avenue, P.O. Box 7190 Madison, WI 53707 Phone: (608) 221-6200 Fax: (608) 221-6208	Integral Designs 3628 Burnsland Road SE Calgary, Alberta Canada T2M 4L5 Phone: (403) 285-9731
Geotek, Inc. P.O. Box 607, 13433 Highway 52 SW Chatfield, MN 55923 Phone: (507) 867-4243 Fax: (507) 867-3713	Hadley Products Company Route 1 Marietta, OH 45750 Phone: (614) 373-9298	Internet, Inc. 2730 Nevada Avenue North Minneapolis, MN 55427 Phone: 800-328-8456 Phone: (612) 541-9690 Fax: (612) 541-9692
Geyer Irrigation 700 5th Street Arbuckle, CA 95912 Phone: (916) 476-2253 Fax: (916) 476-2256	Hancock Trap Company P.O. Box 268 Custer, SD 57730 Phone: (605) 673-4128	J.A. Cissel Manufacturing Company P.O. Box 2025 Lakewood, NJ 08701 Phone: 800-631-2234 Fax: (908) 901-1166
GMK Company 43 Pineview Avenue, B18 Cardiff, NJ 08232 Phone: (609) 641-8490	Harmon International, Inc. P.O. Box 1827 Minot, ND 58702 Phone: (701) 839-6717 Fax: (701) 839-8679	J.C. Ehrlich Chemical Company 500 Spring Ridge Drive Reading, PA 19612 Phone: 800-488-9495 Phone: (215) 372-9700 Fax: (215) 378-9744
Goodart's P.O. Box 1466 Hemphill, TX 75948 Phone: 800-458-6608	Hartman's Plantation, Inc. 310 60th Street, P.O. Box E Grand Junction, MI 49056-0805 Phone: (616) 253-4281 Fax: (616) 253-4457	J/J Fur Shop 717 North 23rd Street Hot Springs, SD 57747 Phone: (605) 745-5114
Grassland Supply Route 3, P.O. Box 6 Council Grove, KS 66846 Phone: 800-527-5487 Phone: (316) 767-5487 Fax: (316) 767-6679	H.B. Sherman Traps, Inc. P.O. Box 20267 Tallahassee, FL 32316 Phone (904) 562-5566	

Johnny Stewart 5100 Fort Avenue, P.O. Box 7594 Waco, TX 76714-7594 Phone: (817) 772-3261 Fax: (817) 772-3670	Leggett's Supplies 7308 Monroe Road Boonsboro, MD 21713 Phone: (310) 432-6210 Fax: (301) 432-8480	Miller Net and Twine P.O. Box 18787, 1674 Getwell Road Memphis, TN 38181-0787 Phone: 800-423-6603 Fax: (901) 743-6580
J.T. Eaton & Company, Inc. 1393 East Highland Road Twinsburg, OH 44087 Phone: 800-321-3421 Phone: (216) 425-7801 Fax: (216) 425-8353	LiphaTech, Inc. 3600 West Elm Street Milwaukee, WI 53209 Phone: 800-558-1003 Phone: (414) 351-1476 Fax: (414) 351-1847	Minnesota Plasti-Catch P.O. Box 43 Darwin, MN 55234 Phone: (612) 275-2523
Kemi-K Products, Inc. P.O. Box 21 Yakima, WA 98907 Phone: 800-321-5354 Phone: (509) 453-1314	Live Wire Products, Inc. 1127 E Street Marysville, CA 95901 Phone: 800-272-9045 Phone: (916) 743-9045 Fax: (916) 743-0609	Minnesota Trapline Products 6699 156th Avenue NW Pennock, MN 56279 Phone: (612) 599-4176 Fax: (612) 599-4314
Ketch-All Company 4149 Santa Fe Road, #2 San Luis Obispo, CA 93401 Phone: (805) 543-7223 Fax: (805) 543-7145	Manufacturing Systems, Inc. Tru-Catch Traps 300 Industrial Street, P.O. Box 816 Belle Fourche, SD 57717-0816 Phone: 800-247-6132 Phone: (605) 892-2717 Fax: (605) 892-6327	Mississippi Valley Forest Products, Inc. P.O. Box 1128 Dubuque, IA 52004 Phone: (319) 583-2795
Keystone Steel & Wire 7000 SW Adams Street Peoria, IL 61641 Phone: 800-447-6444 Phone: (309) 697-7422	Margo Supplies, Ltd. P.O. Box 5400 High River, Alberta Canada T1V 1M5 Phone: (403) 652-1932 Fax: (403) 652-3511	Mitlyng Development P.O. Box 43 Darwin, MI 55324 Phone: (612) 275-2523
K Fence Systems Route 1, P.O. Box 195 Zumbro Falls, MN 55991 Phone: (507) 753-2943 Fax: (507) 753-2706	Marshall Hyde, Inc. P.O. Box 497 Port Huron, MI 48060 Phone: (313) 982-2140	M.J. Flynn, Inc. 6408 Collamer Road East Syracuse, NY 13057-1032 Phone: (315) 437-6536 Fax: (315) 432-1315
Kiwi Fence Systems 1145 East Roy Furman Highway Waynesburg, PA 15370-8070 Phone: (412) 627-8158 Fax: (412) 627-9791	McGill Metal Products Company 142 East Prairie Street, P.O. Box 177 Marengo, IL 60152 Phone: (815) 568-7244	M&M Fur Company P.O. Box 15 Bridgewater, SD 57319-0015 Phone: 800-658-5554 Phone: (605) 729-2535 Fax: (605) 729-2536
Kness Manufacturing Company, Inc. Highway 5 South, P.O. Box 70 Albia, IA 52351-0070 Phone: 800-247-5062 Phone: (515) 932-7846 Fax: (515) 932-2456	Medlinc of Colorado 623 Broken Spoke Road Grand Junction, CO 81054 Phone: (303) 241-0366 Fax: (303) 241-0366	Monterey Chemical Company 5150 North 6th Street P.O. Box 5317 Fresno, CA 93755 Phone: (209) 225-4770 Fax: (209) 225-1310
Krofick Outdoor Supply 30 Lightcap Road Latrobe, PA 15650 Phone: (412) 537-7923	Micro-Gen Equipment Corporation 10700 Sentinel Drive San Antonio, TX 78217 Phone: 800-777-8570 Phone: (210) 654-8570 Fax: (210) 654-3613	Montgomery Traps, Inc. P.O. Box 121 Mahaffey, PA 15757 Phone: (814) 277-6653
Laird Plastics, Inc. 6311 Erdman Avenue Baltimore, MD 21205-3585 Phone: (410) 485-9100 Fax: (410) 485-3033	Miller Chemical and Fertilizer Corporation P.O. Box 333, Radio Road Hanover, PA 17331 Phone: 800-233-2040 Phone: (717) 632-8921 Fax: (717) 632-4581	Morrison Manufacturing Corporation Highway 175, P.O. Box 52 Morrison, IA 50657 Phone: 800-648-CAGE Phone: (319) 345-6406 Fax: (319) 345-6429
Lakeshore Enterprises 2804 Benzie Highway Benzonia, MI 49616 Phone: (616) 882-9601	Motomco, Ltd. 3699 Kinsman Boulevard Madison, WI 53704 Phone: (813) 447-3417 Fax: (608) 241-2238	

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National Live Trap Corporation P.O. Box 302 Tomahawk, WI 54487 Phone: (715) 453-2249 Fax: (715) 453-4705	O'Gorman Enterprises P.O. Box 491 Broadus, MT 59317 Phone: (406) 436-2234	Pioneer Wildlife Traps 2909 NE Alberta Street Portland, OR 97211 Phone: (503) 249-2935
National Netting, Inc. 6325-C McDonough Drive Norcross, GA 30093 Phone: 800-233-7896 Fax: (404) 441-9260	Orchard Equipment and Supply Company P.O. Box 540, Route 116 Conway, MA 01341 Phone: 800-634-5557	Pisces Industries P.O. Box 576407 Modesto, CA 95355 Phone: (209) 578-5502 Fax: (209) 274-4723
Nature's All Natural Products, Inc. Houlton Road, P.O. Box 378 Island Falls, ME 04747-0378 Phone: (612) 548-3444 Fax: (612) 548-3444	Orchard Supply Company P.O. Box 956 Sacramento, CA 95812-0956 Phone: (916) 446-7821	Plant Pro-Tec, Inc. P.O. Box 902 Palo Cedro, CA 96073 Phone: (916) 547-5450 Fax: (916) 547-5450
Nevada State Department of Agriculture Division of Agriculture 350 Capitol Hill Avenue Reno, NV 89502 Phone: (702) 688-1180 Fax: (702) 688-1178	Pace International, Ltd. P.O. Box 558 500 7th Avenue South Kirkland, WA 98083 Phone: (206) 827-8711 Fax: (206) 822-8261	PMC Specialties Group, Inc. RJ Advantage, Inc. 501 Murray Road Cincinnati, OH 45217 Phone: (513) 482-7370 Fax: (513) 482-7377
New Jersey Fireworks Company P.O. Box 118 Vineland, NJ 08360 Phone: (609) 692-8030	Pace International, Ltd. Leffingwell Division 111 South Berry Street, P.O. Box 1880 Brea, CA 92621 Phone: (714) 529-3973 Fax: (714) 671-2138	Pocatello Supply Depot USDA-APHIS, Animal Damage Control 238 East Dillon Pocatello, ID 83201 Phone: (208) 236-6920 Fax: (208) 236-6922
Nichols Net & Twine Co., Inc. 2200 Highway 111 Granite City, IL 62040 Phone: (618) 797-0211 Fax: (618) 797-0212	Pacific Western Container 1535 East Edinger Avenue Santa Ana, CA 92705 Phone: (714) 547-9266 Fax: (714) 953-9270	Premier Fence Systems P.O. Box 89 Washington, IA 52353 Phone: 800-282-6631 Fax: (319) 653-6304
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Nortech Forest Products, Inc. 7600 West 27th Street, Suite B-11 St. Louis Park, MN 55426 Phone: 800-323-3396 Phone: (612) 922-2520 Fax: (612) 922-3865	Pestcon Systems, Inc. 5611 Capital Center Drive, Suite 302 Raleigh, NC 27606 Phone: 800-548-2778 Phone: (919) 859-2500 Fax: (919) 859-2155	Purina Mills, Inc. P.O. Box 66812, 1401 South Hanley Road St. Louis, MO 63144 Phone: (304) 768-4100 Fax: (304) 768-4143
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Ranchers Supply, Inc. P.O. Box 725 Alpine, TX 79831 Phone: (915) 837-3630	Safeguard Products, Inc. P.O. Box 8 New Holland, PA 17557 Phone: 800-433-1819 Phone: (717) 354-4586	Southwest Power Fence 26321 Highway 281 North San Antonio, TX 78260 Phone: 800-221-0178 Phone: (210) 438-4600 Fax: (210) 438-4604
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Rodent Control Systems, Inc. McKee Engineering Laboratories 7207 Envoy Court, P.O. Box 561544 Dallas, TX 75356 Phone: (214) 638-5324 Fax: (214) 638-5329	Smith & Hawken 35 Corte Madera Mill Valley, CA 94941 Phone: (415) 381-1800	Sudbury Laboratories, Inc. Division of Farnam Companies, Inc. P.O. Box 34820 Phoenix, AZ 85067-4820 Phone: 800-825-2555 Phone: (602) 285-1660 Fax: (602) 285-1803
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R-P Outdoors 505 Polk Street, P.O. Box 1170 Mansfield, LA 71052 Phone: 800-762-2706 Fax: (318) 872-8824	Solvit, Inc. 7001 Raywood Road Madison, WI 53713 Phone: (608) 222-8624 Fax: (608) 222-8733	

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Techfence-Advanced Farm Systems Route 1, P.O. Box 364 Bradford, ME 04410 Phone: (207) 327-1237	Trucall 9527 South Deer Creek Canyon Road Littleton, CO 80127 Phone: (303) 697-4572 Fax: (303) 697-4572	Western Fireworks Company 2542 SE 13th Avenue Canby, OR 97013 Phone: (503) 266-7770
Ted Dodge Service 7604 Michel Road Mountain Ranch, CA 95246 Phone: (209) 754-1216	Twin Mountain Supply Company P.O. Box 2240 San Angelo, TX 76902 Phone: 800-527-0990 Phone: (915) 944-8661 Fax: (915) 949-2047	Wickenkamp Live Trap Manufacturing Route 2 Hedrick, IA 52563 Phone: (515) 661-2156
Teiso Kasei Company 350 South Figueroa Street, Suite 350 Los Angeles, CA 90071 Phone: (213) 608-4389	United Textile Corporation 20 Universal Pl. Carlstat, NJ 07072 Phone: (201) 993-9315 Fax: (201) 993-1378	Wilbur-Ellis Company 191 West Shaw Avenue, Suite 107 P.O. Box 1286 Fresno, CA 98704-2876 Phone: 800-937-3446 Phone: (209) 226-1934 Fax: (209) 226-7630
Tenax Corporation 4800 East Monument Street Baltimore, MD 21205 Phone: 800-356-8495 Phone: (410) 522-7000 Fax: (410) 522-7015	VanWaters and Rogers P.O. Box 34325 Seattle, WA 98124-1325 Phone: (206) 889-3400 Fax: (206) 889-4100	Wilco Distributors, Inc. 1215 West Laurel Avenue P.O. Box 291 Lompoc, CA 93436 Phone: (805) 735-2476 Fax: (805) 735-3629
The Tensar Corporation 1210 Citizens Parkway Morrow, GA 30260 Phone: 800-292-4457 Phone: (404) 968-3255 Fax: (404) 961-8239	Wald & Company 208 Broadway Kansas City, MO 64105 Phone: (806) 842-9299	Wildlife Control Technology, Inc. 2501 North Sunnyside, #103 Fresno, CA 93727 Phone: 800-235-0262 Phone: (209) 294-0262 Fax: (209) 294-0632
Tomahawk Live Trap Company P.O. Box 323 Tomahawk, WI 54487 Phone: 800-27-A-TRAP Phone: (715) 453-3550 Fax: (715) 453-4326	Washington Forest Protection Association 711 Capitol Way, Evergreen Plaza Building Olympia, WA 98501 Phone: (206) 352-1500 Fax: (206) 352-4621	Windear Manufacturing Company 119 Parkway North, P.O. Box 415 Lanesboro, MN 56049 Phone: 800-726-5030 Phone: (507) 467-3714
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Treessentials Company Riverview Station, P.O. Box 7097 St. Paul, MN 55107 Phone: 800-248-8239 Fax: (612) 228-0554	West Virginia Fence Corporation U.S. Route 219 Lindside, WV 24951 Phone: 800-356-5458 Phone: (304) 753-4387 Fax: (304) 753-4827	Z.A. Macabee Gopher Trap Company 110 Loma Alta Avenue Los Gatos, CA 95032-6222 Phone: (408) 354-4158

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